# CHAPTER 72

## LIST OF EFFECTIVE TEMPORARY REVISIONS

FOLLOWING IS A COMPLETE LISTING OF ALL ACTIVE TEMPORARY REVISIONS (TR'S). TR'S NOT LISTED SHOULD BE REMOVED. THE ATA NUMBER, CONFIG CODE AND PAGE NUMBER IDENTIFIES THE PAGE PRECEDING THE TR.

| TR NUMBER | ATA NUMBER | CONFIG CODE | PAGE NUMBER | TR DATE |
|---|---|---|---|---|
| NONE | | | | |

# CHAPTER 72

## ENGINE

## LIST OF EFFECTIVE PAGES

| CHAPTER/ SECTION | PAGE | DATE | CONFIG CODE |
|---|---|---|---|
| List of Effective Pages | 1 | Jun 15/96 | |
| | 2 | Jun 15/96 | |
| | 3 | Jun 15/96 | |
| | 4 | Jun 15/96 | |
| | 5 | Jun 15/96 | |
| | 6 | Jun 15/96 | |
| | 7 | Jun 15/96 | |
| | 8 | Jun 15/96 | |
| | 9/10 | Jun 15/96 | |
| Table of Contents | 1 | May 15/89 | |
| | 2 | May 15/89 | |
| | 3 | May 15/88 | |
| | 4 | Dec 15/91 | |
| | 5 | May 15/90 | |
| | 6 | Dec 15/93 | |
| | 7/8 | Dec 15/95 | |
| 72-00-00 | 1 | Jul 15/83 | |
| 72-00-00 | 2 | Jul 15/83 | |
| 72-00-00 | 3/4 | Jul 15/83 | |
| 72-00-00 | 5/6 | Jul 15/83 | |
| 72-00-00 | 7/8 | Jul 15/83 | |
| 72-00-00 | 9/10 | Jul 15/83 | |
| 72-00-00 | 11 | Jul 15/83 | |
| 72-00-00 | 12 | Jul 15/83 | |
| 72-00-00 | 13 | Jul 15/83 | |
| 72-00-00 | 14 | Jul 15/83 | |
| 72-00-00 | 15 | Jul 15/83 | |
| 72-00-00 | 16 | Jul 15/83 | |
| 72-00-00 | 17 | Jul 15/83 | |
| 72-00-00 | 18 | Jul 15/83 | |
| 72-00-00 | 19 | Jul 15/83 | |
| 72-00-00 | 20 | Jul 15/83 | |
| 72-00-00 | 21 | Jul 15/83 | |
| 72-00-00 | 22 | Jul 15/83 | |
| 72-00-00 | 23 | Jul 15/83 | |
| 72-00-00 | 24 | Jul 15/83 | |
| 72-00-00 | 25 | Jul 15/83 | |
| 72-00-00 | 26 | Jul 15/83 | |
| 72-00-00 | 27 | Jul 15/83 | |
| 72-00-00 | 28 | Jul 15/83 | |
| 72-00-00 | 29 | Jul 15/83 | |
| 72-00-00 | 30 | Jul 15/83 | |
| 72-00-00 | 31/32 | Jul 15/83 | |
| 72-00-00 | 301 | May 15/77 | |
| 72-00-00 | 302 | May 15/77 | |
| 72-00-00 | 303 | May 15/77 | |
| 72-00-00 | 304 | May 15/77 | |
| 72-00-00 | 305 | May 15/77 | |
| 72-00-00 | 306 | Nov 15/78 | |
| 72-00-00 | 307 | Nov 15/78 | |
| 72-00-00 | 308 | Nov 15/78 | |
| 72-00-00 | 309 | Nov 15/78 | |
| 72-00-00 | 310 | Nov 15/78 | |
| 72-00-00 | 311 | Nov 15/78 | |
| 72-00-00 | 312 | Nov 15/78 | |
| 72-00-00 | 313 | Nov 15/78 | |
| 72-00-00 | 314 | Dec 15/80 | |
| 72-00-00 | 601 | Nov 15/89 | |
| 72-00-00 | 602 | Nov 15/89 | |
| 72-00-00 | 603 | Nov 15/87 | |
| 72-00-00 | 604 | Nov 15/87 | |
| 72-00-00 | 605 | May 15/85 | |
| 72-00-00 | 606 | May 15/85 | |
| 72-00-00 | 607 | Nov 15/85 | |
| 72-00-00 | 608 | Nov 15/87 | |
| 72-00-00 | 609 | Nov 15/85 | |
| 72-00-00 | 610 | Nov 15/89 | |
| 72-00-00 | 611 | Nov 15/89 | |
| 72-00-00 | 612 | Dec 15/91 | |
| 72-00-00 | 613 | Nov 15/87 | |
| 72-00-00 | 614 | Nov 15/85 | |
| 72-00-00 | 615 | Nov 15/85 | |
| 72-00-00 | 616 | Nov 15/85 | |
| 72-00-00 | 617 | Nov 15/85 | |
| 72-00-00 | 618 | Nov 15/85 | |
| 72-00-00 | 619 | Nov 15/85 | |
| 72-00-00 | 620 | Nov 15/85 | |
| 72-00-00 | 621 | Nov 15/85 | |
| 72-00-00 | 622 | Nov 15/85 | |
| 72-00-00 | 623 | Nov 15/85 | |
| 72-00-00 | 624 | Nov 15/85 | |
| 72-00-00 | 625 | Nov 15/85 | |

| CHAPTER/ SECTION | PAGE | DATE | CONFIG CODE |
|---|---|---|---|
| 72-00-00 | 626 | Nov 15/89 | |
| 72-00-00 | 627 | Nov 15/89 | |
| 72-00-00 | 628 | Nov 15/89 | |
| 72-00-00 | 629 | Nov 15/89 | |
| 72-00-00 | 630 | Nov 15/89 | |
| 72-00-00 | 631 | Nov 15/87 | |
| 72-00-00 | 632 | Nov 15/87 | |
| 72-00-00 | 633 | Nov 15/85 | |
| 72-00-00 | 634 | Nov 15/85 | |
| 72-00-00 | 635 | Nov 15/85 | |
| 72-00-00 | 636 | Nov 15/85 | |
| 72-00-00 | 637 | Nov 15/85 | |
| 72-00-00 | 638 | Nov 15/87 | |
| 72-00-00 | 639 | Nov 15/85 | |
| 72-00-00 | 640 | Nov 15/85 | |
| 72-00-00 | 641 | Nov 15/85 | |
| 72-00-00 | 642 | Nov 15/87 | |
| 72-00-00 | 643 | Nov 15/87 | |
| 72-00-00 | 644 | Nov 15/87 | |
| 72-00-00 | 645 | Nov 15/85 | |
| 72-00-00 | 646 | Nov 15/85 | |
| 72-00-00 | 647 | Nov 15/85 | |
| 72-00-00 | 648 | Nov 15/85 | |
| 72-00-00 | 649 | Nov 15/85 | |
| 72-00-00 | 650 | Nov 15/85 | |
| 72-00-00 | 651 | May 15/89 | |
| 72-00-00 | 652 | Nov 15/87 | |
| 72-00-00 | 653 | Nov 15/87 | |
| 72-00-00 | 654 | Nov 15/85 | |
| 72-00-00 | 655 | Nov 15/85 | |
| 72-00-00 | 656 | Nov 15/87 | |
| 72-00-00 | 657 | Nov 15/85 | |
| 72-00-00 | 658 | Nov 15/85 | |
| 72-00-00 | 659 | Nov 15/85 | |
| 72-00-00 | 660 | Nov 15/85 | |
| 72-00-00 | 661 | Nov 15/85 | |
| 72-00-00 | 662 | Nov 15/85 | |
| 72-00-00 | 663 | Nov 15/85 | |
| 72-00-00 | 664 | Nov 15/85 | |
| 72-00-04 | 401 | Nov 15/83 | |
| 72-00-04 | 402 | Nov 15/83 | |
| 72-00-04 | 403 | Nov 15/83 | |
| 72-00-04 | 404 | Nov 15/83 | |
| 72-00-04 | 405 | Nov 15/83 | |
| 72-00-04 | 406 | Nov 15/83 | |
| 72-00-06 | 401 | May 15/90 | |
| 72-00-06 | 402 | May 15/90 | |
| 72-00-06 | 403 | May 15/90 | |

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|---|---|---|---|
| 72-00-06 | 404 | May 15/90 | |
| 72-00-06 | 405 | Dec 15/92 | |
| 72-00-06 | 406 | May 15/90 | |
| 72-00-06 | 407 | May 15/90 | |
| 72-00-06 | 408 | May 15/90 | |
| 72-00-06 | 409 | Nov 15/89 | |
| 72-00-06 | 410 | Nov 15/89 | |
| 72-00-06 | 411 | Nov 15/89 | |
| 72-00-06 | 412 | May 15/90 | |
| 72-00-06 | 413 | May 15/90 | |
| 72-00-06 | 414 | May 15/90 | |
| 72-00-06 | 415 | May 15/90 | |
| 72-00-06 | 416 | May 15/90 | |
| 72-00-06 | 417 | May 15/90 | |
| 72-00-06 | 418 | May 15/90 | |
| 72-00-06 | 419 | May 15/90 | |
| 72-00-06 | 420 | May 15/90 | |
| 72-00-06 | 421 | May 15/90 | |
| 72-00-06 | 422 | May 15/90 | |
| 72-00-06 | 423 | May 15/90 | |
| 72-00-06 | 424 | May 15/90 | |
| 72-00-06 | 425/426 | Dec 15/92 | |
| 72-01-00 | 1 | May 15/87 | |
| 72-01-00 | 2 | May 15/86 | |
| 72-01-00 | 3 | May 15/86 | |
| 72-01-00 | 4 | May 15/87 | |
| 72-01-00 | 5 | May 15/87 | |
| 72-01-00 | 6 | May 15/87 | |
| 72-01-00 | 7 | May 15/87 | |
| 72-01-00 | 8 | May 15/86 | |
| 72-01-00 | 9 | May 15/86 | |
| 72-01-00 | 10 | May 15/86 | |
| 72-01-00 | 11 | May 15/86 | |
| 72-01-00 | 12 | May 15/86 | |
| 72-01-00 | 13 | May 15/87 | |
| 72-01-00 | 14 | May 15/86 | |
| 72-01-00 | 15 | May 15/86 | |
| 72-01-00 | 16 | May 15/87 | |
| 72-01-00 | 17/18 | May 15/86 | |
| 72-01-00 | 19/20 | May 15/86 | |
| 72-01-00 | 21/22 | May 15/86 | |
| 72-01-00 | 301 | Nov 15/85 | |
| 72-01-00 | 302 | Nov 15/85 | |
| 72-01-00 | 303/304 | Nov 15/85 | |
| 72-01-00 | 401 | Nov 15/86 | |
| 72-01-00 | 402 | Nov 15/86 | |
| 72-01-00 | 403 | May 15/90 | |
| 72-01-00 | 404 | Nov 15/86 | |

| CHAPTER/ SECTION | PAGE | DATE | CONFIG CODE |
|---|---|---|---|
| 72-01-00 | 405 | Jun 15/95 | |
| 72-01-00 | 406 | Jun 15/95 | |
| 72-01-00 | 407 | Dec 15/91 | |
| 72-01-00 | 408 | Nov 15/86 | |
| 72-01-00 | 409 | Nov 15/86 | |
| 72-01-00 | 410 | Nov 15/86 | |
| 72-01-00 | 411 | Jun 15/95 | |
| 72-01-00 | 412 | May 15/90 | |
| 72-01-00 | 413 | Nov 15/86 | |
| 72-01-00 | 414 | Nov 15/86 | |
| 72-01-00 | 415 | May 15/90 | |
| 72-01-00 | 416 | May 15/90 | |
| 72-01-00 | 417 | Nov 15/86 | |
| 72-01-00 | 418 | Nov 15/86 | |
| 72-01-00 | 419 | Dec 15/94 | |
| 72-01-00 | 420 | May 15/87 | |
| 72-01-00 | 421 | Nov 15/86 | |
| 72-01-00 | 422 | Nov 15/86 | |
| 72-01-00 | 423 | Nov 15/86 | |
| 72-01-00 | 424 | May 15/87 | |
| 72-01-00 | 425 | Nov 15/86 | |
| 72-01-00 | 426 | Nov 15/86 | |
| 72-01-00 | 427 | May 15/87 | |
| 72-01-00 | 428 | Nov 15/86 | |
| 72-01-00 | 429 | Nov 15/86 | |
| 72-01-00 | 430 | Nov 15/86 | |
| 72-01-00 | 431 | May 15/87 | |
| 72-01-00 | 432 | Nov 15/86 | |
| 72-01-00 | 433 | Nov 15/86 | |
| 72-01-00 | 434 | Nov 15/86 | |
| 72-01-00 | 435 | May 15/87 | |
| 72-01-00 | 436 | Nov 15/86 | |
| 72-01-00 | 437 | Nov 15/86 | |
| 72-01-00 | 438 | Nov 15/86 | |
| 72-01-00 | 439/440 | Jun 15/95 | |
| 72-01-00 | 501 | Nov 15/85 | |
| 72-01-00 | 502 | Nov 15/85 | |
| 72-01-00 | 503 | May 15/77 | |
| 72-01-00 | 504 | Nov 15/85 | |
| 72-01-00 | 505 | Nov 15/85 | |
| 72-01-00 | 506 | May 15/77 | |
| 72-01-00 | 507 | Nov 15/85 | |
| 72-01-00 | 508 | May 15/77 | |
| 72-01-00 | 509 | Nov 15/85 | |
| 72-01-00 | 510 | Nov 15/85 | |
| 72-01-00 | 511/512 | Nov 15/85 | |
| 72-01-00 | 601 | May 15/89 | |
| 72-01-00 | 602 | May 15/87 | |
| 72-01-00 | 603 | May 15/86 | |
| 72-01-00 | 604 | Mar 15/91 | |
| 72-01-00 | 605 | Mar 15/91 | |
| 72-01-00 | 606 | Mar 15/91 | |
| 72-01-00 | 607 | Mar 15/91 | |
| 72-01-00 | 608 | Mar 15/91 | |
| 72-01-00 | 609 | May 15/89 | |
| 72-01-00 | 610 | Mar 15/91 | |
| 72-01-00 | 611 | Mar 15/91 | |
| 72-01-00 | 612 | May 15/87 | |
| 72-01-00 | 613 | Mar 15/91 | |
| 72-01-00 | 614 | Mar 15/91 | |
| 72-01-00 | 615 | Dec 15/92 | |
| 72-01-00 | 616 | Dec 15/92 | |
| 72-01-00 | 617 | Dec 15/92 | |
| 72-01-00 | 618 | Dec 15/92 | |
| 72-01-00 | 701 | Nov 15/87 | |
| 72-01-00 | 702 | Dec 15/91 | |
| 72-01-00 | 703 | Dec 15/91 | |
| 72-01-00 | 704 | Dec 15/91 | |
| 72-01-00 | 705 | Dec 15/91 | |
| 72-01-00 | 706 | Dec 15/91 | |
| 72-01-01 | 401 | Nov 15/87 | |
| 72-01-01 | 402 | Nov 15/83 | |
| 72-01-01 | 403 | Nov 15/87 | |
| 72-01-01 | 404 | Nov 15/87 | |
| 72-01-01 | 601 | Jul 15/84 | |
| 72-01-01 | 602 | Jul 15/84 | |
| 72-01-01 | 603 | Jul 15/84 | |
| 72-01-01 | 604 | Jul 15/84 | |
| 72-02-00 | 1 | Jun 15/80 | |
| 72-02-00 | 2 | Jun 15/80 | |
| 72-02-00 | 3 | May 15/77 | |
| 72-02-00 | 4 | May 15/77 | |
| 72-02-00 | 5 | May 15/77 | |
| 72-02-00 | 6 | May 15/77 | |
| 72-02-00 | 7/8 | May 15/77 | |
| 72-02-01 | 401 | Feb 15/82 | |
| 72-02-01 | 402 | Feb 15/82 | |
| 72-02-01 | 403/404 | Feb 15/82 | |
| 72-03-00 | 1 | May 15/77 | |
| 72-03-00 | 2 | May 15/77 | |
| 72-03-00 | 3 | May 15/77 | |
| 72-03-00 | 4 | May 15/77 | |
| 72-03-00 | 5 | May 15/77 | |
| 72-03-00 | 6 | May 15/77 | |
| 72-03-00 | 7 | May 15/77 | |
| 72-03-00 | 8 | May 15/77 | |

| CHAPTER/ SECTION | PAGE | DATE | CONFIG CODE |
|---|---|---|---|
| 72-03-00 | 9/10 | May 15/77 | |
| 72-03-00 | 201 | Nov 15/83 | |
| 72-03-00 | 202 | Nov 15/83 | |
| 72-03-00 | 301/302 | Sep 15/80 | |
| 72-03-00 | 401 | Nov 15/85 | |
| 72-03-00 | 402 | Nov 15/85 | |
| 72-03-00 | 403 | Nov 15/85 | |
| 72-03-00 | 404 | Jun 15/79 | |
| 72-03-00 | 405 | Jun 15/79 | |
| 72-03-00 | 406 | Nov 15/85 | |
| 72-03-00 | 407 | May 15/87 | |
| 72-03-00 | 408 | Nov 15/85 | |
| 72-03-00 | 409 | Nov 15/78 | |
| 72-03-00 | 410 | Nov 15/78 | |
| 72-03-00 | 411 | Nov 15/81 | |
| 72-03-00 | 412 | Nov 15/82 | |
| 72-03-00 | 413 | Nov 15/85 | |
| 72-03-00 | 414 | Nov 15/85 | |
| 72-03-00 | 415 | Nov 15/85 | |
| 72-03-00 | 416 | Nov 15/85 | |
| 72-03-00 | 417 | Nov 15/82 | |
| 72-03-00 | 418 | Nov 15/85 | |
| 72-03-00 | 419 | Nov 15/86 | |
| 72-03-00 | 420 | Mar 15/83 | |
| 72-03-00 | 421 | May 15/89 | |
| 72-03-00 | 422 | Dec 15/91 | |
| 72-03-00 | 423 | Dec 15/91 | |
| 72-03-00 | 424 | Dec 15/91 | |
| 72-03-00 | 425 | Dec 15/91 | |
| 72-03-00 | 426 | Dec 15/91 | |
| 72-03-00 | 427 | Dec 15/91 | |
| 72-03-00 | 428 | Dec 15/91 | |
| 72-03-00 | 429 | Dec 15/91 | |
| 72-03-00 | 430 | Dec 15/91 | |
| 72-03-00 | 431 | Dec 15/91 | |
| 72-03-00 | 432 | Dec 15/91 | |
| 72-03-00 | 433/434 | Dec 15/91 | |
| 72-03-00 | 601 | May 15/90 | |
| 72-03-00 | 602 | May 15/77 | |
| 72-03-00 | 603 | May 15/90 | |
| 72-03-00 | 604 | Dec 15/91 | |
| 72-03-00 | 605 | May 15/90 | |
| 72-03-00 | 606 | May 15/90 | |
| 72-03-00 | 607 | May 15/90 | |
| 72-03-00 | 608 | May 15/90 | |
| 72-03-00 | 609/610 | Dec 15/91 | |
| 72-30-00 | 701 | Nov 15/89 | |
| 72-30-00 | 702 | Nov 15/89 | |
| 72-30-00 | 703 | May 15/89 | |
| 72-30-00 | 704 | Nov 15/87 | |
| 72-30-00 | 705/706 | Nov 15/89 | |
| 72-31-01 | 501 | May 15/77 | |
| 72-31-01 | 502 | May 15/77 | |
| 72-31-01 | 503 | May 15/77 | |
| 72-31-01 | 504 | May 15/77 | |
| 72-31-01 | 505/506 | Nov 15/81 | |
| 72-31-01 | 601 | Jun 15/93 | |
| 72-31-01 | 602 | Jun 15/93 | |
| 72-31-01 | 603 | Jun 15/93 | |
| 72-31-01 | 604 | May 15/77 | |
| 72-31-01 | 605 | Jun 15/93 | |
| 72-31-01 | 606 | Jun 15/93 | |
| 72-31-01 | 607 | Jun 15/93 | |
| 72-31-01 | 608 | Dec 15/91 | |
| 72-31-01 | 609 | May 15/89 | |
| 72-31-01 | 610 | May 15/89 | |
| 72-31-01 | 611 | May 15/85 | |
| 72-31-01 | 612 | Mar 15/91 | |
| R 72-31-01 | 613 | Jun 15/96 | |
| 72-31-01 | 614 | Jun 15/94 | |
| 72-31-01 | 615 | Jun 15/94 | |
| 72-31-01 | 616 | May 15/89 | |
| 72-31-01 | 617 | Mar 15/91 | |
| R 72-31-01 | 618 | Jun 15/96 | |
| 72-31-01 | 619 | Mar 15/91 | |
| 72-31-01 | 620 | Mar 15/91 | |
| 72-31-01 | 621 | Dec 15/91 | |
| R 72-31-01 | 622 | Jun 15/96 | |
| R 72-31-01 | 623/624 | Jun 15/96 | |
| 72-31-01 | 701 | May 15/89 | |
| 72-31-01 | 702 | May 15/89 | |
| 72-31-01 | 703/704 | May 15/89 | |
| 72-31-01 | 801 | Mar 15/91 | |
| 72-31-01 | 802 | Nov 15/87 | |
| 72-31-01 | 803 | Nov 15/87 | |
| 72-31-01 | 804 | Nov 15/87 | |
| 72-31-01 | 805 | Nov 15/87 | |
| 72-31-01 | 806 | Nov 15/87 | |
| 72-31-01 | 807 | Nov 15/87 | |
| 72-31-01 | 808 | Nov 15/87 | |
| 72-31-01 | 809 | Nov 15/87 | |
| 72-31-01 | 810 | Nov 15/87 | |
| 72-31-01 | 811 | May 15/77 | |
| 72-31-01 | 812 | Nov 15/87 | |
| 72-31-01 | 813 | Nov 15/87 | |
| 72-31-01 | 814 | Nov 15/87 | |

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|---|---|---|---|
| 72-31-01 | 815 | Nov 15/87 | |
| 72-31-01 | 816 | May 15/89 | |
| 72-31-01 | 817 | Nov 15/87 | |
| 72-31-01 | 818 | Nov 15/87 | |
| 72-31-01 | 819 | Nov 15/87 | |
| 72-31-01 | 820 | Nov 15/87 | |
| 72-31-01 | 821 | May 15/89 | |
| 72-31-01 | 822 | Nov 15/87 | |
| 72-31-01 | 823 | Nov 15/87 | |
| 72-31-01 | 824 | Nov 15/87 | |
| 72-31-01 | 825 | Nov 15/87 | |
| 72-31-01 | 826 | Nov 15/87 | |
| 72-31-01 | 827 | Nov 15/87 | |
| 72-31-01 | 828 | Nov 15/87 | |
| 72-31-01 | 829 | Nov 15/87 | |
| 72-31-01 | 830 | Nov 15/87 | |
| 72-31-01 | 831 | May 15/85 | |
| 72-31-01 | 832 | Nov 15/87 | |
| 72-31-01 | 833 | Nov 15/87 | |
| 72-31-01 | 834 | Nov 15/87 | |
| 72-31-01 | 835 | Nov 15/87 | |
| 72-31-01 | 836 | Feb 15/78 | |
| 72-31-01 | 837 | Nov 15/87 | |
| 72-31-01 | 838 | Nov 15/87 | |
| 72-31-01 | 839 | Nov 15/87 | |
| 72-31-01 | 840 | Nov 15/87 | |
| 72-31-01 | 841 | Nov 15/87 | |
| 72-31-01 | 842 | May 15/85 | |
| 72-31-01 | 843 | May 15/85 | |
| 72-31-01 | 844 | Nov 15/87 | |
| 72-31-01 | 845 | Nov 15/87 | |
| 72-31-01 | 846 | Nov 15/87 | |
| 72-31-01 | 847 | Mar 15/91 | |
| 72-31-01 | 848 | Mar 15/91 | |
| 72-31-01 | 849 | Mar 15/91 | |
| 72-31-01 | 850 | Mar 15/91 | |
| 72-31-01 | 851 | Mar 15/91 | |
| 72-31-01 | 852 | Mar 15/91 | |
| 72-31-01 | 853 | Mar 15/91 | |
| 72-31-01 | 854 | Mar 15/91 | |
| 72-31-02 | 401 | Jun 15/94 | 1 |
| 72-31-02 | 402 | Jun 15/94 | 1 |
| 72-31-02 | 403 | Mar 15/91 | 1 |
| 72-31-02 | 404 | Nov 15/85 | 1 |
| 72-31-02 | 405 | Nov 15/85 | 1 |
| 72-31-02 | 406 | Dec 15/95 | 1 |
| 72-31-02 | 407 | Nov 15/85 | 1 |
| 72-31-02 | 408 | Nov 15/85 | 1 |
| 72-31-02 | 409 | Nov 15/85 | 1 |
| 72-31-02 | 410 | Nov 15/85 | 1 |
| 72-31-02 | 411 | Nov 15/85 | 1 |
| 72-31-02 | 412 | Nov 15/85 | 1 |
| 72-31-02 | 413 | Jun 15/94 | 1 |
| 72-31-02 | 414 | Jun 15/94 | 1 |
| 72-31-02 | 415 | Jun 15/94 | 1 |
| 72-31-02 | 416 | Jun 15/94 | 1 |
| 72-31-02 | 417 | Jun 15/94 | 1 |
| 72-31-02 | 418 | Jun 15/94 | 1 |
| 72-31-02 | 419 | Jun 15/94 | 1 |
| 72-31-02 | 420 | Jun 15/94 | 1 |
| 72-31-02 | 421 | Jun 15/94 | 1 |
| 72-31-02 | 422 | Jun 15/94 | 1 |
| 72-31-02 | 423 | Jun 15/94 | 1 |
| 72-31-02 | 424 | Jun 15/94 | 1 |
| 72-31-02 | 425 | Jun 15/94 | 1 |
| 72-31-02 | 426 | Jun 15/94 | 1 |
| 72-31-02 | 427 | Jun 15/94 | 1 |
| 72-31-02 | 428 | Jun 15/94 | 1 |
| 72-31-02 | 429 | Jun 15/94 | 1 |
| 72-31-02 | 430 | Jun 15/94 | 1 |
| 72-31-02 | 431 | Dec 15/95 | 1 |
| 72-31-02 | 432 | Dec 15/95 | 1 |
| 72-31-02 | 433 | Dec 15/95 | 1 |
| 72-31-02 | 434 | Dec 15/94 | 1 |
| 72-31-02 | 435 | Dec 15/95 | 1 |
| 72-31-02 | 436 | Jun 15/94 | 1 |
| 72-31-02 | 437 | Dec 15/94 | 1 |
| 72-31-02 | 438 | Jun 15/94 | 1 |
| 72-31-02 | 439 | Jun 15/94 | 1 |
| 72-31-02 | 440 | Jun 15/94 | 1 |
| 72-31-02 | 441 | Dec 15/94 | 1 |
| 72-31-02 | 442 | Jun 15/94 | 1 |
| 72-31-02 | 443/444 | Dec 15/95 | 1 |
| 72-31-02 | 401 | Nov 15/85 | 2 |
| 72-31-02 | 402 | Jun 15/94 | 2 |
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# CHAPTER 72

## ENGINE

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| | Removal/Installation | | 401 | ALL |
| | Inspection/Check | | 601 | ALL |
| | PRIMARY OIL PUMP ASSEMBLY | 72-63-03 | | |
| | Removal/Installation | | 401 | ALL |

# ENGINE - DESCRIPTION AND OPERATION

LOW PRESSURE COMPRESSOR

1. L.P. compressor rotor (fan) blades
2. L.P. compressor case
3. Rotor shaft curvic coupling
4. Rotor shaft front roller bearing
5. Outlet guide vanes
6. L.P. compressor rotor shaft

INTERMEDIATE PRESSURE COMPRESSOR

7. Fixed inlet guide vanes
8. Variable inlet guide vanes
9. Stage 1 rotor blades
10. Stage 1 stator vanes
11. I.P. compressor case
12. Stage 1 disc
13. Rotor shaft front roller bearing
14. I.P. compressor rotor front stub shaft
15. Rotor drum curvic coupling
16. Outlet guide vanes

INTERMEDIATE CASE

17. I.P. compressor rotor rear stub shaft
18. L.P. compressor rotor shaft location bearing
19. H.S. external gearbox drive shaft and shroud
20. H.S. external gearbox drive housing
21. I.P. compressor rotor shaft location bearing
22. H.P. compressor rotor shaft location bearing
23. Internal gearbox
24. H.P. compressor rotor front stub shaft
25. H.P. compressor rotor front curvic coupling

HIGH PRESSURE COMPRESSOR

26. Stage 1 disc
27. Stage 1 rotor blades
28. Stage 1 stator vanes
29. H.P. compressor case
30. H.P. air offtake annular duct
31. Outlet guide vanes

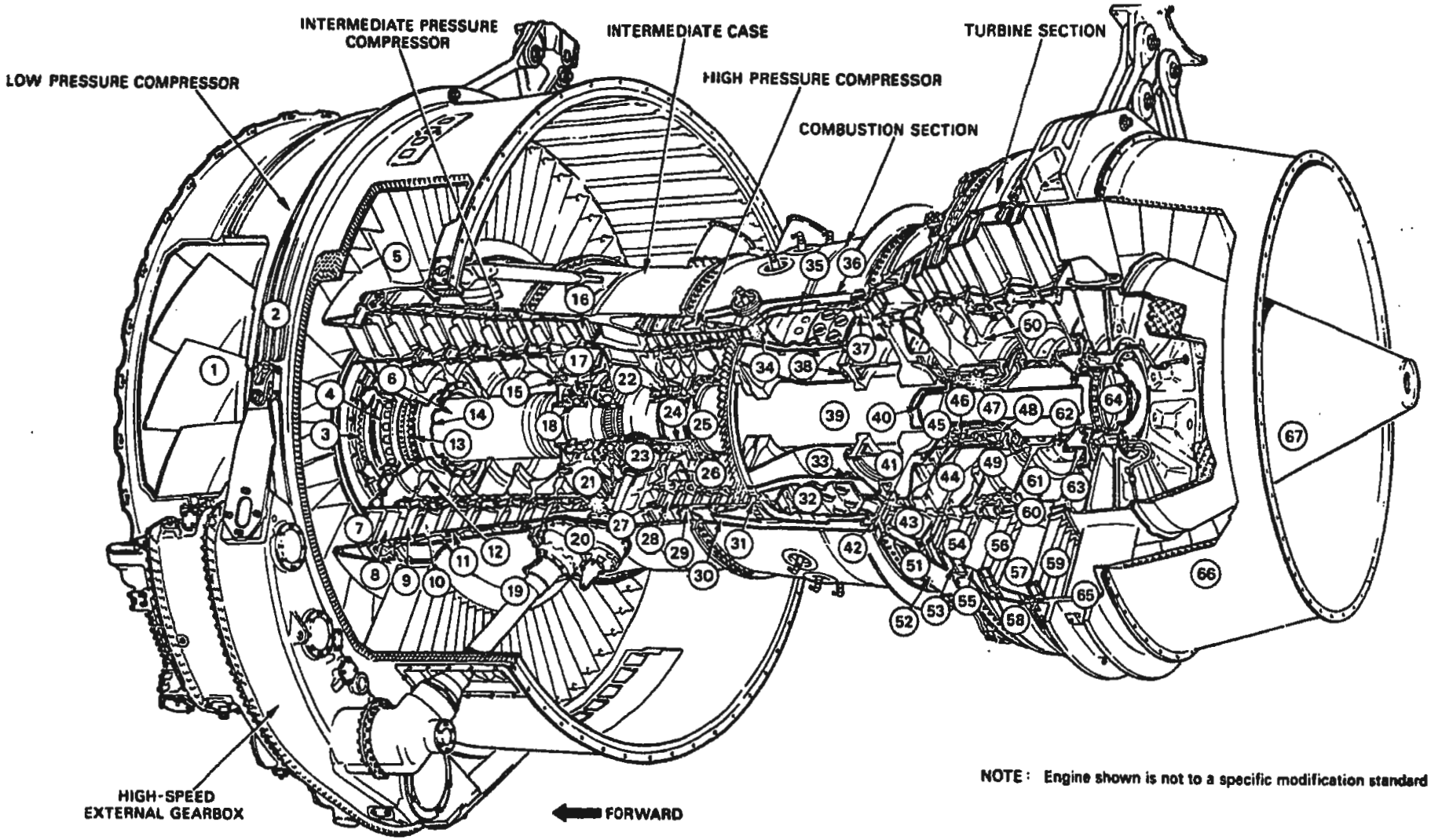
COMBUSTION SECTION

32. Annular combustion chamber
33. Rear inner combustion case
34. Fuel spray nozzle
35. Front inner combustion case
36. Combustion outer case

TURBINE SECTION

37. H.P. turbine nozzle guide vanes
38. H.P. turbine shaft to H.P. compressor bolted joint
39. I.P. turbine shaft
40. L.P. turbine shaft
41. H.P. turbine disc
42. H.P. turbine blades
43. I.P. turbine nozzle guide vanes
44. I.P. turbine disc
45. H.P. turbine stub shaft
46. H.P. turbine roller bearing
47. I.P. turbine roller bearing
48. I.P. turbine stub shaft
49. L.P. turbine shaft to L.P. stage 2 turbine disc curvic coupling
50. L.P. stage 1 disc
51. I.P. turbine blades
52. I.P. turbine outer case
53. L.P. stage 1 nozzle guide vanes
54. L.P. stage 1 blades
55. L.P. stage 2 nozzle guide vanes
56. L.P. stage 2 blades
57. L.P. stage 3 nozzle guide vanes
58. L.P. turbine outer case
59. L.P. stage 3 blades
60. L.P. stage 1 to stage 2 disc curvic coupling
61. L.P. stage 2 disc
62. L.P. stage 2 to stage 3 disc curvic coupling
63. L.P. stage 3 disc
64. L.P. turbine roller bearing
65. L.P. turbine bearing and support assembly
66. Exhaust transition case
67. Exhaust cone

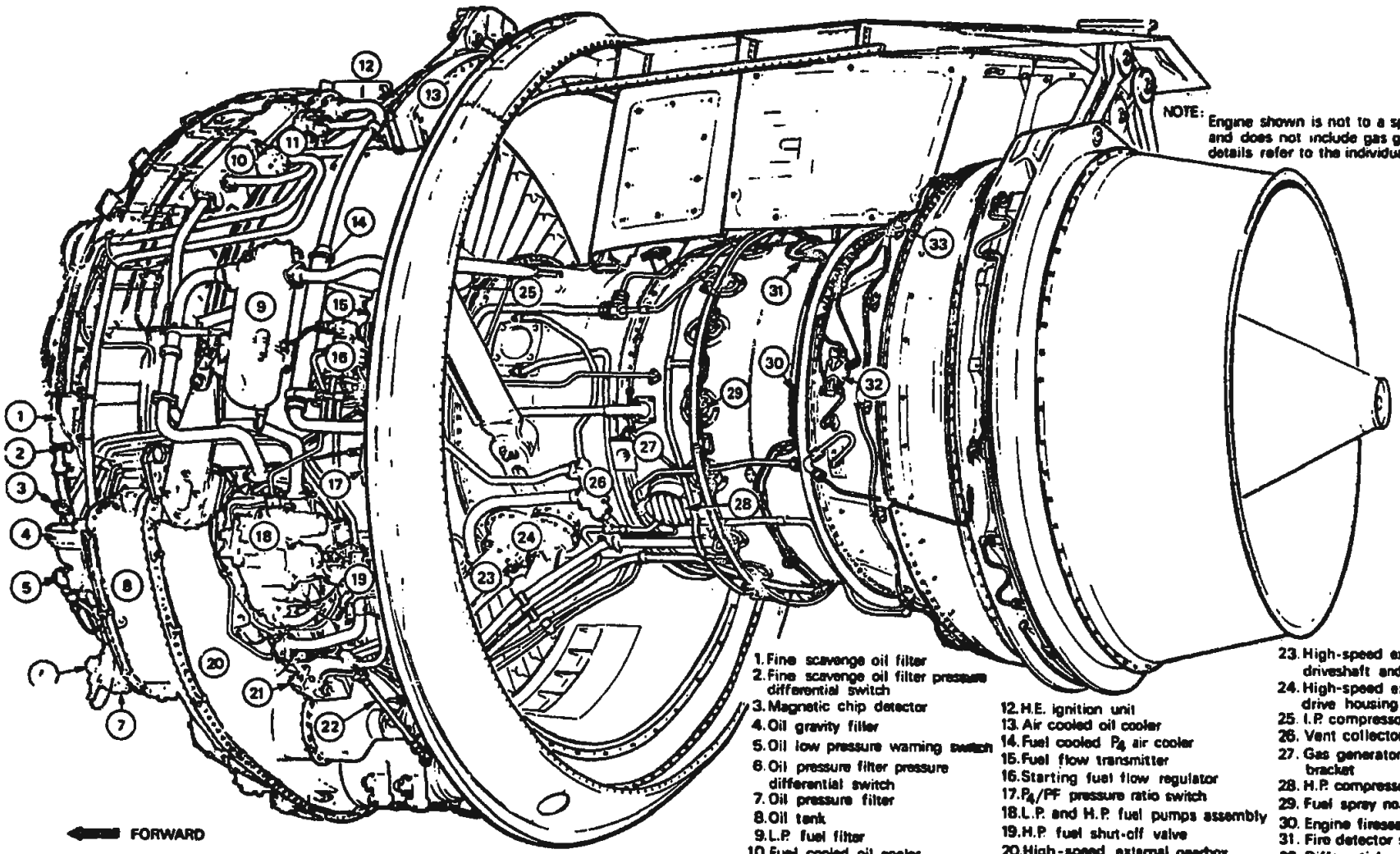
Key to Fig.1 36422



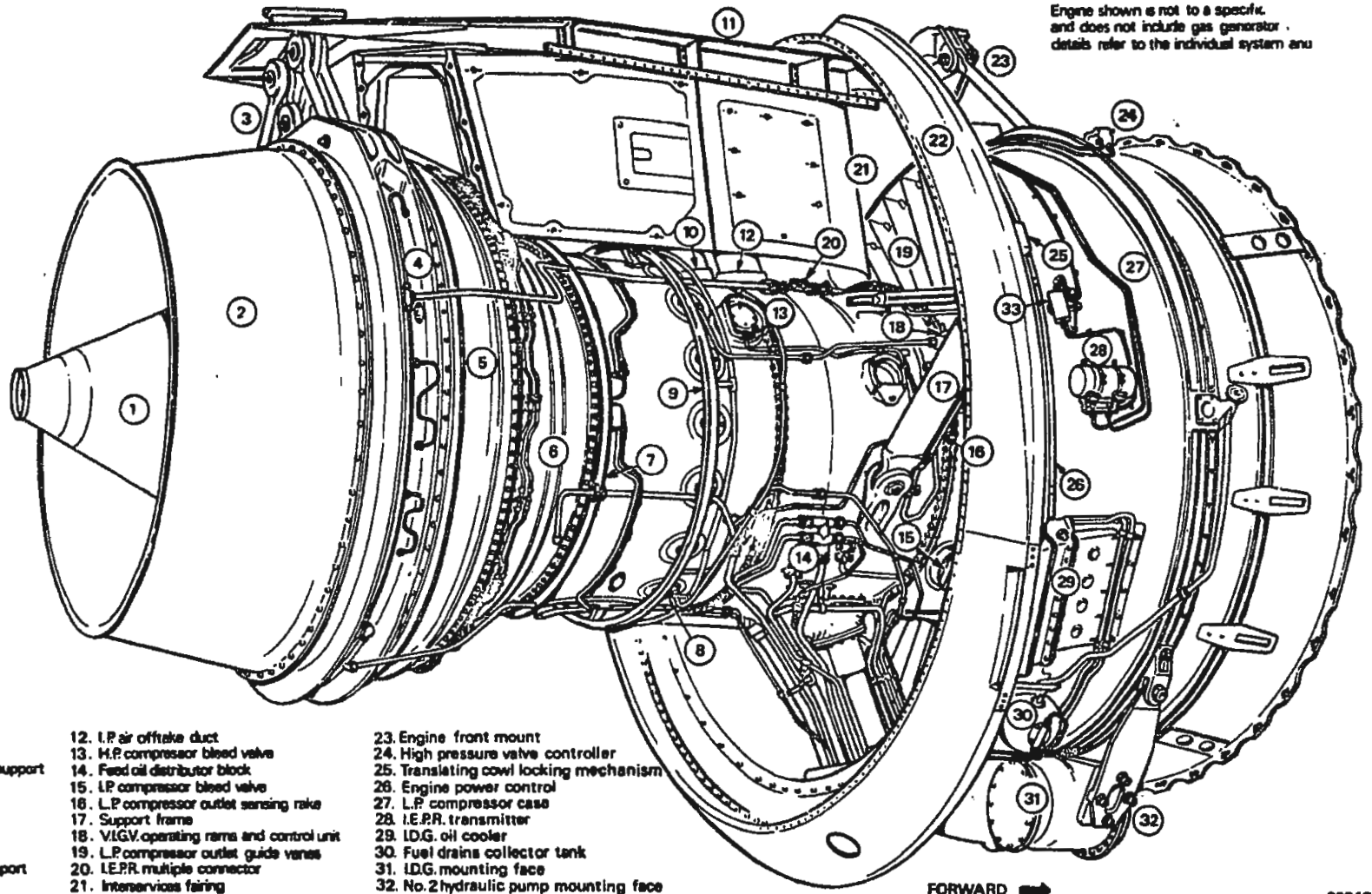

NOTE : Engine shown is not to a specific modification standard

22230C

Engine internal construction
Fig.1

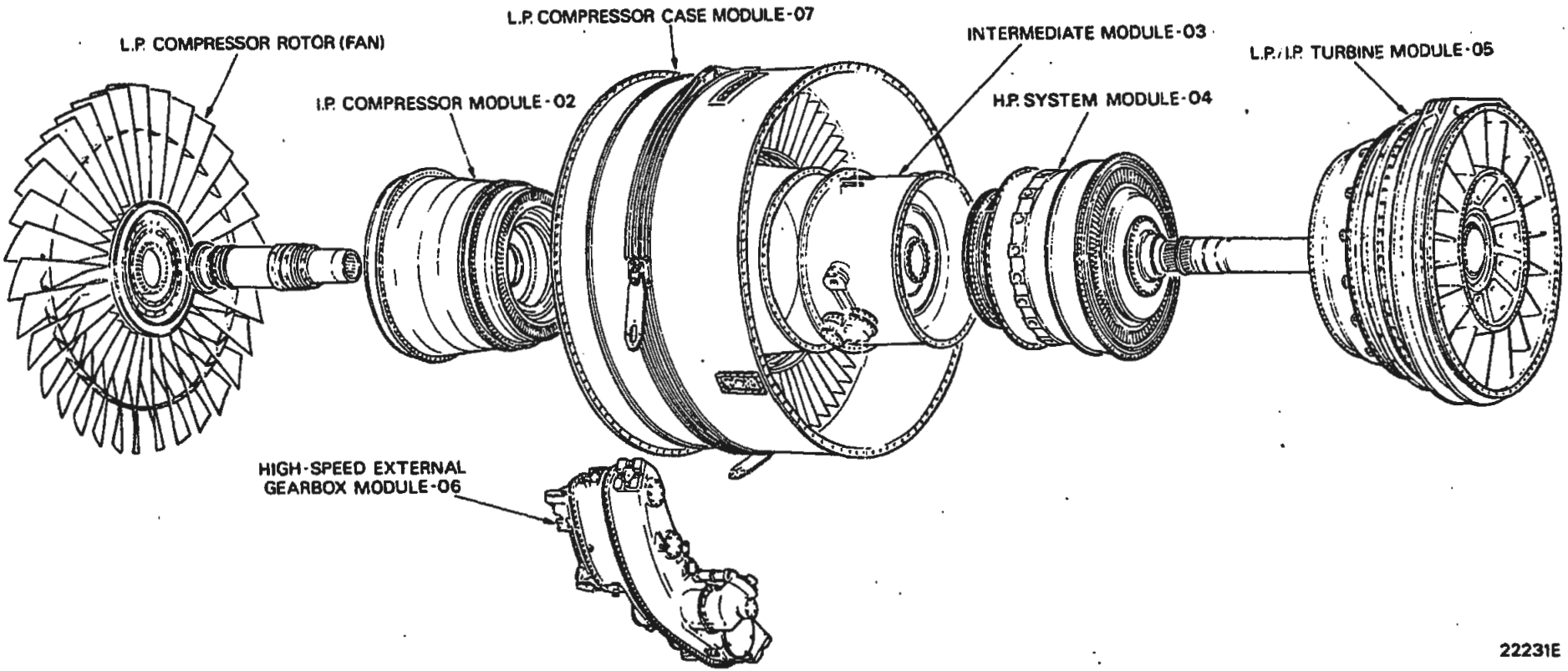

NOTE: Engine shown is not to a specific modification st.. and does not include gas generator fairings For pr. details refer to the individual system and unit descrip.
FORWARD
1. Fine scavenge oil filter
2. Fine scavenge oil filter pressure differential switch
3. Magnetic chip detector
4. Oil gravity filler
5. Oil low pressure warning switch
6. Oil pressure filter pressure differential switch
7. Oil pressure filter
8. Oil tank
9. L.P. fuel filter
10. Fuel cooled oil cooler
11. Control valve
12. H.E. ignition unit
13. Air cooled oil cooler
14. Fuel cooled $P_4$ air cooler
15. Fuel flow transmitter
16. Starting fuel flow regulator
17. $P_4/PF$ pressure ratio switch
18. L.P. and H.P. fuel pumps assembly
19. H.P. fuel shut-off valve
20. High-speed external gearbox
21. Fuel flow regulator
22. Air throttle connecting link
23. High-speed external gearbox driveshaft and shroud
24. High-speed external gearbox drive housing
25. I.P. compressor bleed valve
26. Vent collector block
27. Gas generator fairing attachment bracket
28. H.P. compressor bleed valve
29. Fuel spray nozzle assembly
30. Engine fireseal
31. Fire detector sensor
32. Differential expansion switches
33. Thermocouple
22498C

Engine left-hand view
Fig.2


Engine shown is not to a specific and does not include gas generator details refer to the individual system anu
FORWARD
22248C

1. Exhaust cone
2. Exhaust transition case
3. Engine rear mount
4. L.P. turbine bearing and support assembly
5. L.P. turbine case
6. I.P. turbine case
7. Engine firewall
8. H.E. igniter plug
9. Gas generator fairing support
10. H.P. air offtake duct
11. Hoop plate
12. I.P. air offtake duct
13. H.P. compressor bleed valve
14. Feed oil distributor block
15. I.P. compressor bleed valve
16. L.P. compressor outlet sensing rake
17. Support frame
18. V.I.G.V. operating rams and control unit
19. L.P. compressor outlet guide vanes
20. I.E.P.R. multiple connector
21. Interservices fairing
22. Engine firewall
23. Engine front mount
24. High pressure valve controller
25. Translating cowl locking mechanism
26. Engine power control
27. L.P. compressor case
28. I.E.P.R. transmitter
29. I.D.G. oil cooler
30. Fuel drains collector tank
31. I.D.G. mounting face
32. No. 2 hydraulic pump mounting face
33. I.E.P.R. trimmer unit

Engine right-hand view
Fig.3




R
R

Engine module breakdown
Fig.4

EFFECTIVITY: ALL

050B 1E

# ENGINE - DESCRIPTION AND OPERATION

## 1. General

| | | |
|---|---|---|
| | Engine data | |
| | Type number | RB211-22B-02 |
| | Bare engine take-off thrust (I.S.A. sea level static) | 42,000 lb. (188 kN) |
| | Direction of rotation | Anti-clockwise viewed from rear |
| | Pressure ratio | 24.7:1 |
| | By-pass ratio (by-pass flow to gas generator flow) | 5:1 |
| | Fuel specification | Refer to Chapter 12 |
| | Oil specification | Refer to Chapter 12 |
| | Handling data | |
| | Maximum diameter of engine | |
| R | - across the L.P. compressor case front flange | 96.00in. (2438,0 mm.) approximately |
| R | - across the engine front mount and high-speed external gearbox | 105.80in. (2687,0 mm.) approximately |
| R | Overall length of engine - from front of L.P. compressor spinner to rear of exhaust cone | 204.33in. (5190 mm.) approximately |
| R | Weight of dressed basic engine (dry) | 12,000 lb. (5,465 kg) approximately |
| | Centre of gravity | 32in. (813 mm.) rear of engine front mount (approximately) |

The engine, zone 412, 422 and 432, is a high by-pass ratio, three-shaft turbofan consisting, basically, of a gas generator system and a mechanically independent L.P. system.

The gas generator system comprises a seven-stage intermediate pressure (I.P.) compressor, a six-stage high pressure (H.P.) compressor, an annular combustion section and single-stage I.P. and H.P. turbines.

The L.P. system consists of a single-stage compressor (fan) driven by a three-stage turbine.

The L.P. compressor (cold stream) and the gas generator (hot stream) exhaust through separate propelling nozzles as shown in the gas flow diagram (Ref. fig.7). This gives a low acceleration to a large mass of air through the L.P. system while allowing high compression ratios and high turbine entry temperatures in the gas generator system, resulting in good propulsive efficiency.

Curvic couplings incorporated in the H.P. and I.P. rotating assemblies and a splined coupling in the L.P. rotating assembly facilitate module removal and installation. Access ports in the engine cases allow for extensive internal inspection by boroscope.

Also incorporated in the engine are noise and vibration reduction features. Noise reduction is achieved by the use of acoustic linings in the gas generator fairings, parts of the exhaust system and the L.P. compressor case. Vibration is minimized by oil squeeze film damping on the main shaft roller bearings.

The modular construction and main physical features of the engine, together with brief details of systems associated with the basic engine are described in the following paragraphs. More detailed information of the associated systems is given in the relevant Chapter/Section referred to in parenthesis.

Fig.1 illustrates the engine internal construction and fig.2 and 3 illustrate the main features of the engine left-hand and right-hand sides. A diagrammatic view of the main rotating assemblies is illustrated in fig.5.

## 2. Description

### A. Module Construction

The engine consists of the following major assemblies (modules) (fig.4).

L.P. compressor rotor (fan) -01
L.P. compressor case -07
I.P. compressor -02
Intermediate case (including internal gearbox and external gearbox drive) -03
H.P. system (including H.P. compressor, combustion section and H.P. turbine) -04
L.P./I.P. turbine -05
High-speed (H.S.) external gearbox -06

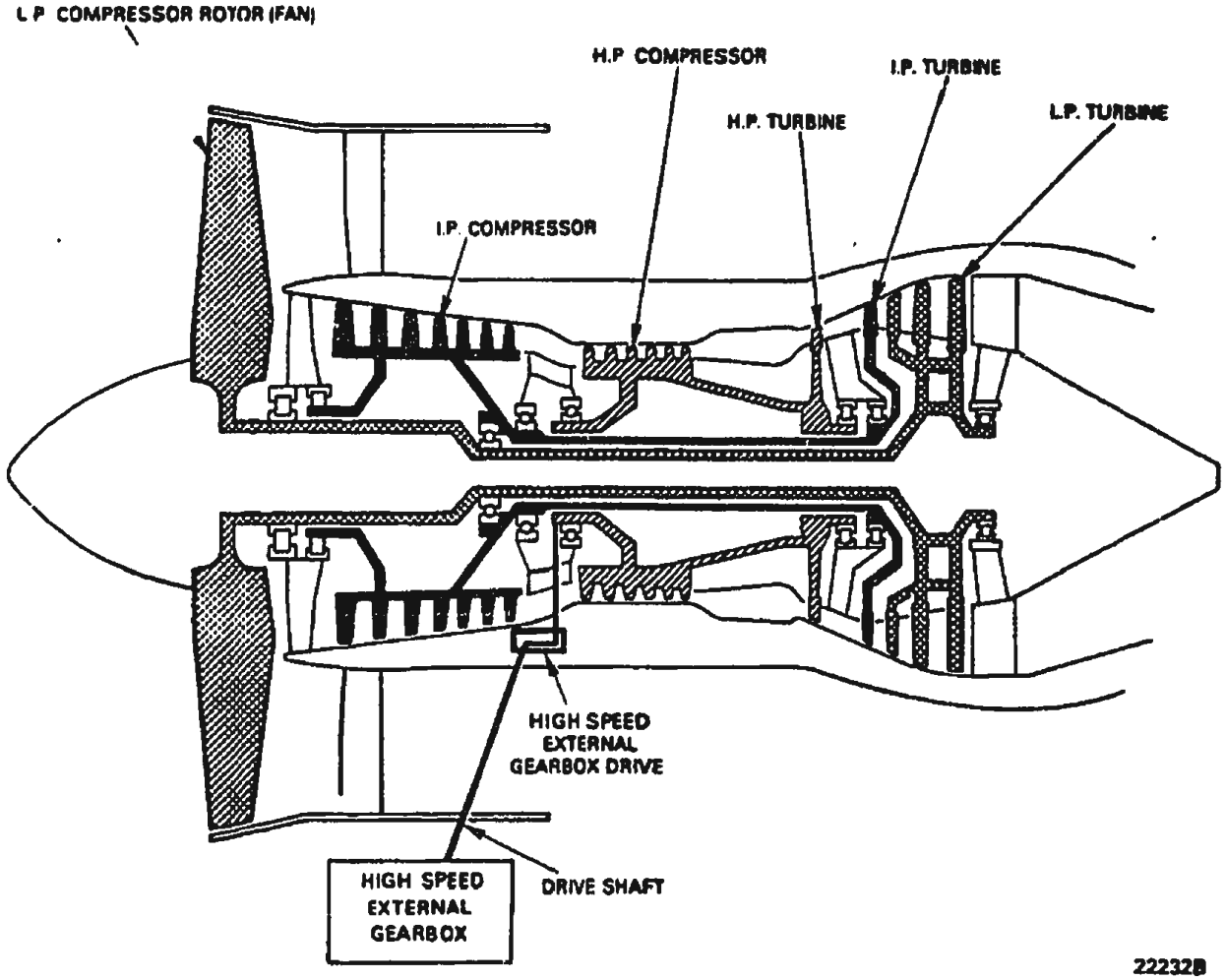
### B. L.P. Compressor Rotor (Module -01)

The L.P. compressor rotor assembly comprises a single-stage rotor and shaft assembly supported on two bearings. A roller bearing, housed in the hub of the I.P. compressor front bearing support, supports the front end of the rotor and the rear end is supported by the L.P. location bearing in the intermediate case.

The single-stage rotor consists of a rotor disc and blades. The blades are annular strutted and are attached to the disc by curved, fir-tree roots.

The disc is secured to the front of the shaft by a curvic coupling. The rear of the shaft incorporates internal helical splines and houses a rigid splined coupling, locking sleeve and retaining nut and bolt assembly, through which the drive is received from the L.P. turbine shaft.

R In the event of L.P. compressor shaft failure the retention of and the drive to the L.P. compressor rotor is effected
R by an axial retainer and an additional shaft positioned within the L.P. compressor shaft.




Main rotating assemblies
Fig.5

The rear end of this fail safe shaft is secured by the L.P. compressor/turbine shaft coupling retaining nut while a flange at the front end of the shaft extends forward of the front face of the L.P. compressor disc. Two sets of splines, one at the front and one midway along the shaft, mate with corresponding internal splines on the L.P. compressor shaft.

C. L.P. Compressor Case (Module -07)

The L.P. compressor case consists of two main assemblies, the front section forming the L.P. compressor rotor case and rotor blade containment ring and the rear section housing the outlet guide vanes. The outlet guide vane assembly supports the forward end of the gas generator together with a support structure, consisting of two 'A' frames, that bolts to the compressor case, adjacent to the rear flange, and to lugs on the intermediate case.

The engine front mount assembly is secured to the rear section of the L.P. compressor case and provision is made for mounting the high-speed external gearbox. Various components of engine systems are mounted on the exterior of the case while the interior is lined with acoustic material to assist in noise reduction.

D. I.P. Compressor (Module -02)

The I.P. compressor is a seven-stage axial flow compressor consisting of a rotor drum and seven stages of blades driven by a single-stage I.P. turbine. The rotor drum consists of two sections bolted together, the front section containing blade stages 1 to 5 and the rear section stages 6 and 7. The rotor assembly locates in the I.P. compressor case that houses the six stages of stator vanes and a single stage of outlet guide vanes. The I.P. compressor case is secured at the front to the I.P. compressor front bearing support and variable inlet guide vane (V.I.G.V.) actuating mechanism assembly, which houses a single stage of fixed inlet guide vanes and a single stage of V.I.G.V. A stub shaft is secured to the front end of the rotor drum and is supported in the front bearing housing. A rear stub shaft, secured by a curvic coupling, is located in the intermediate case and transmits the drive from the I.P. turbine.

The I.P. compressor case consists of two axially split half cases containing stages 1 to 4 stator vanes, two separate half ring assemblies containing stages 5 and 6 stator vanes and a full ring of outlet guide vanes. An actuating ring, mounted on the I.P. compressor front bearing support, connects to the actuating levers of the V.I.G.V. and is operated by two pneumatic rams to vary the V.I.G.V. angle (Ref. 75-31-00). The fixed inlet guide vanes support a central hub, housing the L.P. and I.P. rotor roller bearings, and their hollow sections accommodate oil feed, return and vent tubes and the shaft speed pulse probe wires (Ref. 77-12-00).

Air for engine internal cooling and sealing (Ref. 72-02-00) and anti-icing (Ref. 75-11-00) is taken from stages 4 and 7 of the compressor. Stage 7 air is also used for aircraft and engine services (Ref. 75-00-00).

E. Intermediate Case (Module -03)

The intermediate case forms the transition between the I.P. and H.P. compressors. On engines without S.B.72-3310 the case is an aluminium casting and on engines with S.B.72-3310 a steel fabrication. The case consits of an annular duct secured at the front end to the L.P. compressor inner case and O.G.V. inner annulus, and at the rear end to the combustion outer case.

The duct is supported by ten hollow struts, eight of which collect a percentage of the I.P. compressor air and deliver it to an offtake mounted on top of the case. Of the two remaining struts, one houses the radial drive shaft for the H.S. external gearbox drive and the other strut houses the oil feed and vent for the location bearings. The return oil passes through one of the hollow struts at the bottom of the case. The inboard ends of the struts extend through the inner wall to support the internal gearbox housing.

A mounting face on the lower outer case provides an attachment for the H.S. external gearbox drive and bevel gear housing, and mounting lugs are provided for the L.P. compressor case support structure 'A' frames.

The intermediate case accommodates the internal gearbox. This comprises a bevel gear, driven by the H.P. rotor, that transmits the drive to the H.S. external gearbox. The H.P. rotor drive is supported by the H.P. rotor location bearing, the outer race of which is secured to the intermediate case.

The drive from the internal gearbox is transmitted to the H.S. external gearbox input drive, through the external gearbox drive housing and a shrouded drive shaft.

F. H.P. System (Module -04)

The H.P. system comprises the H.P. compressor assembly, the combustion section and the H.P. turbine assembly.

(1) H.P. compressor assembly

The H.P. compressor is a six-stage axial flow compressor consisting of a rotor drum and six stages of blades driven by a single-stage H.P. turbine. The rotor drum consists of three sections, the front section, comprising stages 1 and 2, and the rear section, comprising stages 4, 5 and 6, are secured to the front and rear faces of the stage 3 disc.

A stub shaft, secured by a curvic coupling to the front of the stage 3 disc, provides support for the H.P. compressor rotor location bearing and the drive to the internal gearbox.

Extensions from the rear of stage 6 and the front face of the H.P. turbine disc are secured to each other through a compressor/turbine support disc, to provide the drive for the compressor.

The H.P. compressor case consists of six separate case assemblies and five stages of stator vanes. The stator vanes are located in separate, split, shroud ring assemblies and the half-ring and stator assemblies are secured, together with the cases, around the compressor rotor. A locating cone, bolted between the 2nd and 3rd stage outer cases, locates the H.P. compressor assembly within the combustion outer case.

Air from the H.P. compressor stage 3 is bled off during engine starting and in the lower speed range (Ref. 75-32-00). Stage 3 and stage 6 air is used for engine internal cooling and sealing (Ref. 72-02-00). Stage 6 air is also used to supplement the air from the I.P. compressor offtake (Ref. 75-00-00) for aircraft services.

(2) Combustion section

The combustion section consists of an annular liner assembly supported within an inner combustion case that directs the compressor delivery air into the annular duct formed by the liner. The whole assembly is further enclosed within a combustion outer case assembly, that provides the location for the 18 fuel spray nozzles (Ref. 73-11-00), which is secured at the front end to the intermediate case and at the rear end to the I.P. turbine case. The inner combustion case is attached, through a support bracket, to the front flange of the combustion outer case.

The annular liner assembly comprises a front liner and a rear inner and outer liner. The front liner has an integral entry snout and diffuser chamber forward of the fuel spray nozzles, an air metering plate, and thermal shield segments around each spray nozzle. Holes in the wall of the front liner provide for flame stabilization and efficient combustion together with sufficient dilution to reduce the flame temperature to a figure acceptable to the turbine components. A discharge nozzle formed by the rear inner and outer liners, directs the gas stream to the H.P. turbine nozzle guide vanes.

The H.P. compressor outlet guide vanes are integral with the forward section of the front inner combustion case and the H.P. turbine nozzle guide vanes are located between the rear inner and outer liners.

(3) H.P. turbine assembly

The single-stage H.P. turbine is secured to and provides the drive for the H.P. compressor rotor through the compressor/turbine support disc. A flanged extension on the rear face of the turbine disc provides location for the disc cooling air seals (Ref. 72-02-00) and the rear stub shaft. The stub shaft incorporates the inner race for the H.P. turbine rear roller bearing, mounted in the H.P./I.P. turbine bearings support assembly, and provides the rear support for the H.P. rotating assembly.

The H.P. turbine blades have integral and interlocking shrouds, and sealing lands that form a ring at their periphery and so prevent gas leakage past the tips. The blade roots are of 'fir tree' form and locate in corresponding sections in the disc.

The blades are cooled internally by air impingement on the inner surface of the leading edge of each blade (Ref. 72-02-00).

G. L.P./I.P. Turbine Assembly (Module -05)

(1) I.P. turbine

The single stage I.P. turbine is secured to and provides the drive for the I.P. compressor rotor assembly. A cylindrical section of the turbine disc extends rearwards and forms a flange to which the main I.P. turbine shaft and stub shaft are secured.

The stub shaft and main shaft extend forward through the bore of the disc, where the stub shaft forms the inner race for the I.P. turbine roller bearing. The main shaft passes through the bore of the stub shaft and the bore of the H.P. turbine and compressor shaft to connect to the I.P. compressor rotor rear stub shaft.

(2) L.P. turbine

The three-stage L.P. turbine is secured to and provides the drive for the L.P. compressor rotor assembly. A curvic coupling, on the front face of a drum section forming the bore of the turbine stage 2 disc, is secured to the L.P. turbine shaft that extends forward through the bore of the I.P. shaft to connect with the L.P. compressor rotor shaft.

Stage 1 of the turbine is secured to stage 2 by a curvic coupling, forming a joint between the rear face of the stage 1 disc and the front face of the stage 2 disc.

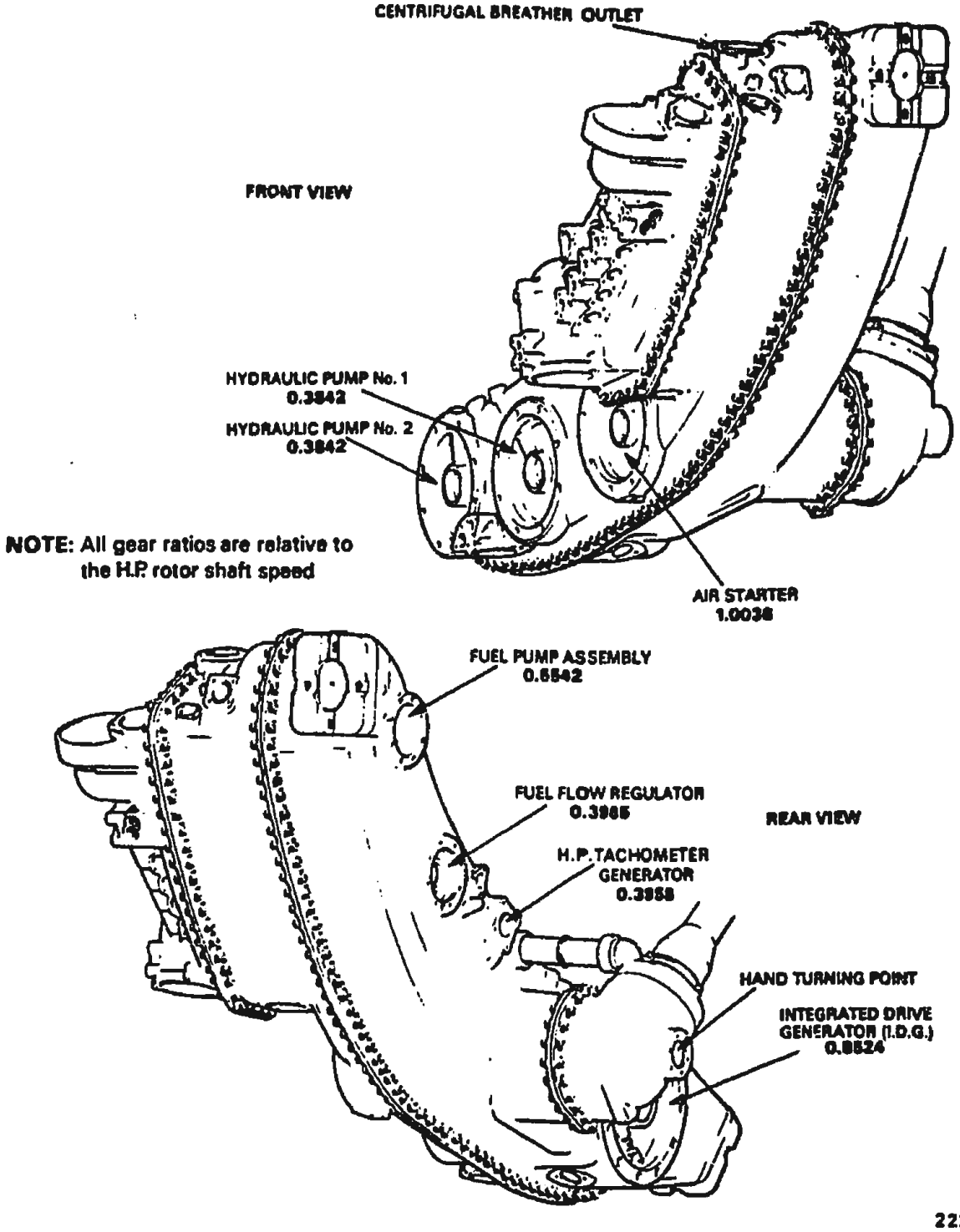
Stage 3 of the turbine is also secured to stage 2 by a curvic coupling forming a joint between the rear face of the drum section and the front face of an extension flange of the stage 3 disc. The extension continues rearward to form a location for the L.P. turbine rear stub shaft that forms the inner race for the L.P. turbine roller bearing.

(3) I.P. and L.P. turbine blades

The I.P. and L.P. turbine blades have integral shrouds and sealing lands forming a ring at their periphery, thus preventing gas leakage at the tips. The blade roots are of 'fir-tree' form and locate in corresponding sections in the turbine discs.

(4) Turbine outer case

The turbine outer case is in two separate sections. The front, I.P. turbine case houses the I.P. and L.P. stage 1 nozzle guide vanes and a support assembly, secured by radial struts to the case, that provides the support for the H.P. and I.P. turbine roller bearings. Oil feed, return and vent tubes pass through three of the I.P. nozzle guide vanes to the H.P. and I.P. turbine roller bearing compartment (Ref. 72-01-00). Thermocouples (Ref. 77-21-00) are fitted in seventeen of the L.P. stage 1 nozzle guide vanes. The front flange of the I.P. turbine case is bolted to the rear flange of the combustion outer case.




External gearbox - Accessory drives and gear ratios
Fig.6

The rear, L.P. turbine case is bolted to the I.P. turbine case and houses the L.P. turbine stages 2 and 3 nozzle guide vanes.

An L.P. turbine bearing and support assembly is bolted to the rear of the L.P. turbine case. The support structure is secured to the case by tangentially arranged struts. Oil feed, return and vent tubes pass through the struts to the L.P. turbine bearing compartment. The case provides attachment for the engine rear mount.

An exhaust transition case and exhaust cone (non-modular items) are bolted to flanges on the rear of the L.P. turbine bearing and support assembly.

H. High-Speed (H.S.) External Gearbox (Module -06)

The H.S. external gearbox is mounted on the L.P. compressor case. It incorporates an integral oil tank for the engine oil system supply and contains the oil pump assembly. Mounting faces are provided for various accessory units.

Fig.6 illustrates the positions of the accessory units on the gearbox and the gear ratio of the drives relative to H.P. compressor shaft speed.

The gearbox is suspended from links attached to the L.P. compressor case, one on each side, and located by a centre spigot mounted on the gearbox close to the radial drive shaft.

Provision is made at the gearbox input drive housing for the insertion of a hand turning tool that connects with the gear train to rotate the H.P. system (Ref. Servicing).

J. Fireseals

An engine firewall is secured to the rear flange of the L.P. compressor case and an engine fireseal is secured around the rear flange of the combustion outer case (Ref. 71-30-00). The firewall and fireseal in conjunction with flame proof panels prevent the spread of flames in the event of an engine external fire. The firewall also serves as the front diaphragm for the cold stream thrust reverser.

K. Mounts

The engine is suspended by two mounts, a front mount on the L.P. compressor case and a rear mount on the L.P. turbine bearing and support assembly (Ref. 71-20-00).

Engine thrust is transmitted to the aircraft through the centre thrust link of the front mount. Side and vertical loads are transmitted through the front and rear mount support links.

Torsional loads are transmitted through the centre links of the rear mount.

L. Engine Drains

Any leakage past the seals of the fuel and non-fuel units and any fuel accumulating in the engine as the result of engine shut-down or a failure to start is collected and disposed of by a drains system (Ref. 71-70-00).

M. Oil System

The oil system (Ref. 72-01-00) is of the full flow, re-circulating type and is entirely self-contained on the engine. It provides lubrication and cooling for bearings, gears and splines together with the supply for the engine main roller bearings squeeze film damping.

The oil is contained in a tank which is an integral part of the H.S. external gearbox and is circulated through the system by a gear-type pressure pump and returned to the tank by six gear-type scavenge pumps.

N. Cooling and Sealing Air System

Cooling the hot areas of the engine and pressurizing the seals to prevent oil and gas leakage is effected by air, tapped from both the I.P. and H.P. compressors (Ref. 72-02-00). Air from the H.P. compressor is also used to cool the H.P. turbine nozzle guide vanes, H.P. turbine blades and the I.P. turbine nozzle guide vanes.

P. Gas Generator Fairings

The gas generator fairings (Ref. 72-03-00) consist of a number of interconnected panels that form a complete drum that extends from the rear of the L.P. compressor outlet guide vane inner platforms to the rear of the exhaust transition case. The fairing provides a smooth shaped inner wall to the L.P. compressor outlet duct and cold stream nozzle.

Q. Fuel System

An L.P. fuel pump supplies a positive fuel feed, through a fuel cooled oil cooler, fuel cooled P4 air cooler, fuel flow transmitter and fuel filter, to a gear-type H.P. fuel pump (Ref. 73-00-00). The delivery from the H.P. pump passes to a fuel flow regulator which schedules the fuel flow requirements. Fuel then passes through an electrically operated shut-off valve, to the fuel spray nozzles.

R. Engine Anti-icing System

The L.P. compressor spinner is anti-iced (Ref. 75-11-00) by a continuous supply of hot air taken from the I.P. compressor. I.P. compressor air is also used for the engine inlet anti-ice system (Ref. 30-21-00).

S. Airflow Control System

Control of the airflow through the I.P. compressor is effected by variable inlet guide vanes (V.I.G.V.) and two I.P. compressor bleed valves (Ref. 75-31-00). The guide vanes are operated, through linkage, by two pneumatic rams, the position of which also governs the operation of the bleed valves through a bleed valve control unit. The position of the rams is controlled by a fluidic control unit.

During engine starting and in the lower speed range a percentage of the H.P. compressor airflow is vented into the cold stream duct through two H.P. compressor bleed valves (Ref. 75-32-00).

T. Engine Control System

Control of the engine in forward and reverse thrust is by movement of levers in the flight station. This movement is transmitted through the engine power and thrust reverser control linkage (Ref. 76-11-00) to the air throttle lever of the fuel flow regulator, to select the required engine power.

U. Engine Indicating

Indication is provided, at the flight station, of the functioning of various systems so that engine operation can be controlled and performance monitored.

Engine thrust is indicated by an integrated engine pressure ratio (I.E.P.R.) system (Ref. 77-11-00) and is displayed in units of E.P.R.

The r.p.m. of each of the three rotating assemblies is measured and indicated as a percentage of the rotational speed (Ref. 77-11-00). The speeds of the L.P. and I.P. rotating assemblies (N1 and N2) are sensed by probes in conjunction with phonic wheels. The H.P. rotating assembly speed (N3) is sensed by a tachometer generator.

Indication of engine temperature (Ref. 77-21-00) is achieved by measuring the turbine gas temperature (T.G.T.). Thermocouples, positioned to sense the temperature at the L.P. turbine stage 1 nozzle guide vanes, produce electrical signals that are transmitted and displayed as a temperature reading.

A fuel indicating system provides indication of low fuel pressure and a warning of excessive pressure drop across the L.P. fuel filter (Ref. 73-31-00). An indication of fuel flow/consumed (Ref. 73-34-00) and fuel temperature (Ref. 73-37-00) is also provided.

An oil pressure indicating and warning system provides indication of engine oil pressure, a warning of low oil pressure and a warning of excessive pressure drop across the pressure oil filter or fine scavenge filter (Ref. 79-31-00). An indication of oil temperature (Ref. 79-34-00) and oil quantity (Ref. 79-37-00) is also provided.

The level of vibration throughout the engine is monitored (Ref. 77-31-00) and an indication of the degree of vibration is provided at the flight station.

The temperature of the engine cooling and sealing air is monitored (Ref. 77-22-00) and an indication of over-temperature is provided at the flight station.

V. Noise Suppression

Noise reduction is achieved by the extensive use of acoustic materials lining parts of the L.P. compressor case, the cold stream thrust reverser, cold stream nozzle, exhaust transition case, exhaust cone and the gas generator fairings.

The inner surface of the L.P. compressor case is lined with expanded aluminium foil honeycomb bonded to the case. Sheets of perforated aluminium are laid over and bonded to the honeycomb to form a smooth even surface for the flow of air through the compressor case.

The cold stream thrust reverser blanking flap assemblies are also lined with honeycomb aluminium foil and covered with perforated aluminium.

Similar honeycomb sections of stainless steel, overlaid with sheets of metallic composite material are used to line the inner surfaces of the exhaust transition case, the outer surface of the exhaust cone and the noise attenuation duct.

To further reduce noise, the gas generator fairings comprise aluminium or steel honeycomb sections, depending upon the panel location in either a hot or cold area, covered with aluminium or steel perforated sheet.

W. Reverse Thrust

To assist in reducing the aircraft forward speed during the landing run each engine is fitted with a cold stream thrust reverser (Ref. 78-30-00).

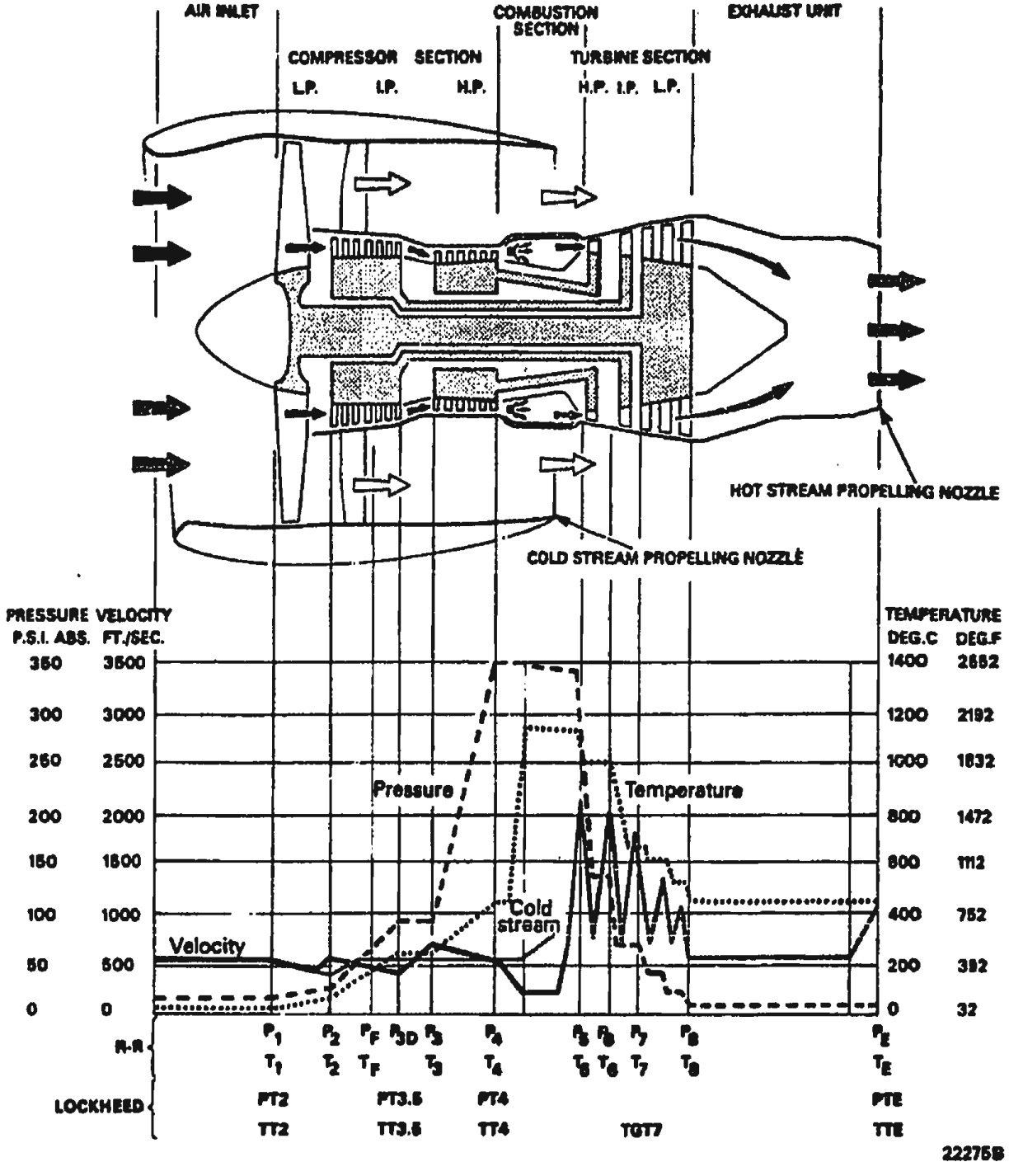
X. Starting

An air starter motor, mounted on the H.S. external gearbox, is used to rotate the H.P. compressor through the gearbox drive. Air to the starter motor is supplied from either an aircraft mounted A.P.U., a ground supply, or cross-bleed from a running engine. Combustion is initiated by two H.E. igniter plugs (Ref. 74-21-00) fitted in two of the fuel spray nozzles. The starting cycle is described in 80-00-00.

## 3. Operation

A. Gas Flow

The engine develops thrust in two non-mixing streams. The single-stage L.P. compressor rotor receives air through the air intake, compresses it and discharges it rearward through the L.P. compressor duct and nozzle (cold stream). A proportion of the total airflow is directed into the gas generator where it is further compressed by the I.P. and H.P. compressors prior to entering the combustion section. Fuel, in the form of a finely atomised spray, is introduced into the combustion chamber where it mixes with the air stream, is ignited and burned. The resultant increase in temperature expands and accelerates the gas stream rearward through the turbine sections. Each turbine system extracts energy from the gas stream to drive its respective compressor system and the gases finally discharge to atmosphere through the exhaust collector and nozzle (hot stream).




Gas flow diagram including location of pressure and temperature symbols
Fig.7

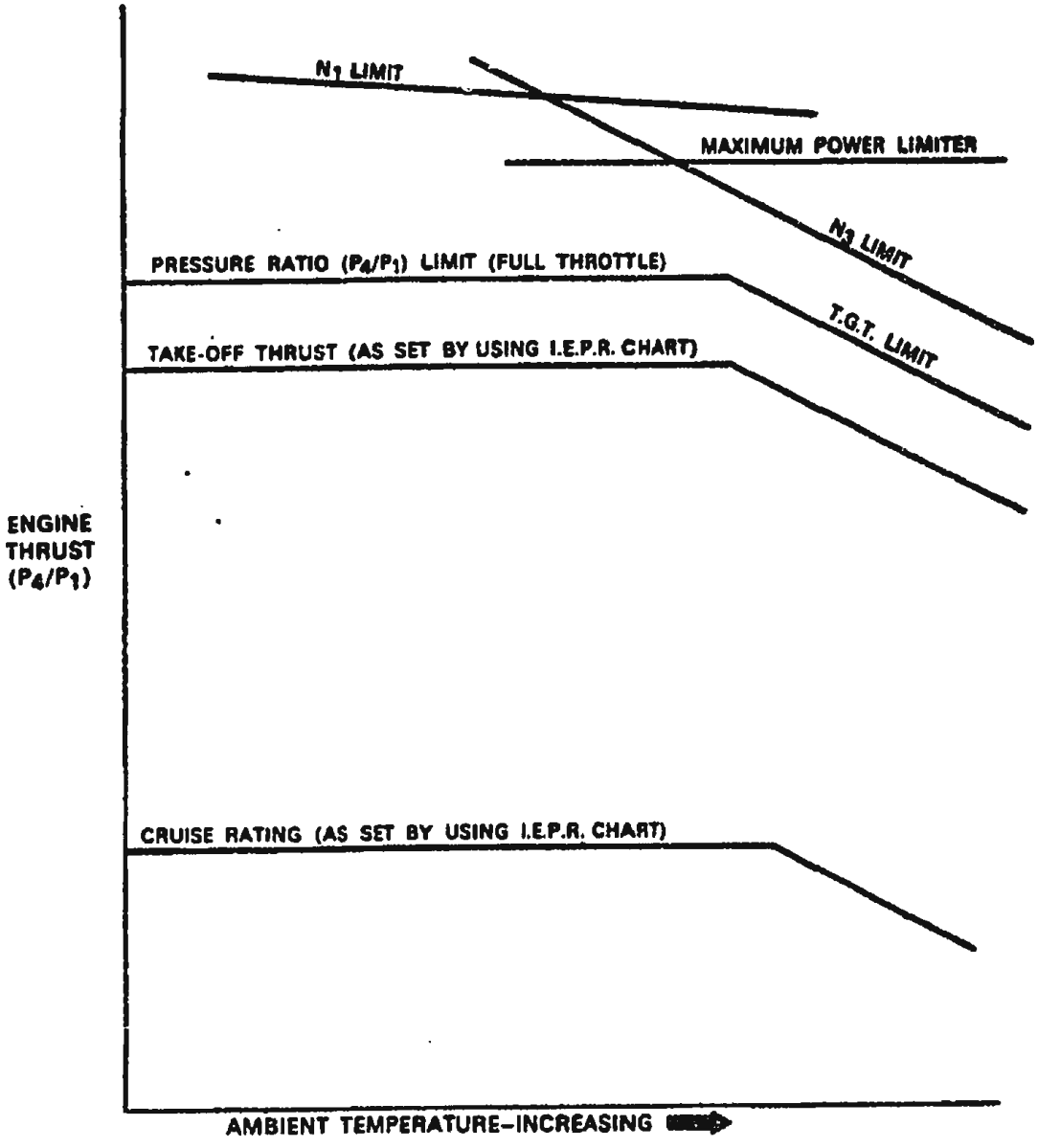
Approximately 84 per cent of the total airflow by-passes the gas generator and the reaction to the acceleration of this flow produces approximately 70 per cent of the total engine thrust.

A gas flow diagram illustrating flow through the engine, together with the trend of pressure, temperature and velocity changes at take-off conditions, is shown in fig.7. The specific Rolls-Royce symbols and corresponding Lockheed symbols denoting pressure and temperature at the various locations throughout the engine are also shown and defined below.

| Symbol | | | Location |
|---|---|---|---|
| R.R. | Lockheed | | |
| P1 T1 | PT2 | TT2 | Engine inlet |
| P2 T2 | | | I.P. compressor entry |
| PF TF | | | L.P. compressor delivery |
| P3 D | PT3.5 | TT3.5 | I.P. compressor delivery |
| P3 T3 | | | H.P. compressor entry |
| P4 T4 | PT4 | TT4 | H.P. compressor delivery |
| P5 T5 | | | H.P. turbine entry |
| P6 T6 | | | I.P. turbine entry |
| P7 T7 | | TGT7 | L.P. turbine entry |
| P8 T8 | | | Exhaust |
| PE TE | PTE | TTE | Hot stream propelling nozzle |

B. Engine Control

A single thrust parameter, Integrated Engine Pressure Ratio (Ref. 77-11-00) is used to determine engine thrust ratings. Thereafter the control system will schedule fuel to the engine to maintain that rating with little or no manual adjustment.


N1 LIMIT
MAXIMUM POWER LIMITER
N3 LIMIT
PRESSURE RATIO (P4/P1) LIMIT (FULL THROTTLE)
T.G.T. LIMIT
TAKE-OFF THRUST (AS SET BY USING I.E.P.R. CHART)
ENGINE THRUST (P4/P1)
CRUISE RATING (AS SET BY USING I.E.P.R. CHART)
AMBIENT TEMPERATURE-INCREASING

24104A

Engine control
Fig.8

Control is achieved (Ref. 73-21-00) by scheduling fuel to the engine pressure ratio P4/P1 (which relates closely to the thrust developed) as a function of throttle lever position and P1.

Control is effected from the pilots throttle lever which when positioned will set a specific P4/P1 ratio for fuel scheduling. Limiting features automatically override manual control in certain conditions to prevent specified parameters (Ref. fig.8) being exceeded.

The control system flat rates engine thrust over a range of ambient temperature as indicated in the trend graph (Ref. fig.8). Thus thrust remains constant at take-off and cruise without throttle trimming, up to a specified ambient temperature. Rated thrust, as can also be seen from the trend graph, is established at a T.G.T. lower than the maximum limit.

The pressure ratio P4/P1 is so scheduled with P1 to provide the required power for the design climb speed schedule at a fixed throttle setting, up to a specified ambient temperature.

## ENGINE - SERVICING

The Servicing procedures described in this section are as follows:

| Paragraph | Procedure |
|---|---|
| 1. | Rotate Engine L.P. System |
| 2. | Rotate Engine I.P. System |
| 3. | Rotate Engine H.P. System |

### 1. Rotate Engine L.P. System

A. Equipment required:

| | |
|---|---|
| XUT.40959 | Work platform, nose cowl |
| 289200 or C 4G 4342 | Protective work mats |

B. Engines No.1 and 3

(1) Position protective work mats or work platform in nose cowl air intake ensuring red warning pennants are clearly visible from aircraft exterior.

C. Engine No.2

(1) Open access doors 433BL and 431AZ.

(2) Position protective work mats in air intake ensuring red warning pennants are clearly visible from aircraft exterior.

D. WARNING: WHEN ROTATING L.P. SYSTEM TAKE CARE TO AVOID INJURY TO FINGERS AND HANDS.
Enter air intake and rotate L.P. system slowly by hand, clockwise or anti-clockwise as required.

E. Engines No.1 and 3

(1) Remove protective work mats or work platform from nose cowl air intake.

F. Engine No.2

(1) Remove protective work mats from air intake.

(2) Close access doors 431AZ and 433BL.

2. Rotate Engine I.P. System

Referenced Procedures

78-30-00 Thrust Reverser - Servicing

WARNING: TO PREVENT L.P. COMPRESSOR WINDMILLING FIT HOT AND COLD STREAM OUTLET BLANKS.

CAUTION: WHEN ROTATING COMPRESSOR, USE EXTREME CARE TO AVOID DAMAGING COMPRESSOR BLADES.

Two methods of I.P. system rotation are described.

Method 1 uses HU.19964 turning tool and involves manual opening of the variable inlet guide vanes before inserting the tool through the front of the engine.

Method 2 uses UT.972 turning tool which can be inserted through the front of the engine without opening the variable inlet guide vanes.

A. Rotate I.P. system - Method 1

(1) Equipment required:

| | |
|---|---|
| HU.19964 | Turning tool |
| XUT.40959 | Work platform, nose cowl |
| 289200 or C 4G 4342 | Protective work mats |
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |

(2) WARNING: ENSURE THRUST REVERSER IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref. 78-30-00).

(3) Engines No.1 and 3

(a) Position protective work mats or work platform in nose cowl air intake ensuring red warning pennants are clearly visible from aircraft exterior.

(4) Engine No.2

(a) Open access doors 433BL and 431AZ.

(b) Position protective work mats in air intake ensuring red warning pennants are clearly visible from aircraft exterior.

(5) Position working platform in cold stream duct.

(6) Enter cold stream duct and open pressure relief door in compressor section R.H. front fairing

(7) Push master ram push rod fully forward to move variable inlet guide vanes to maximum airflow position.

(8) Refer to fig.301, enter air intake and carefully insert HU.19964 turning tool into engine until block (1) abuts inlet guide vanes.

(9) Adjust jack (2) until pad (3) is firmly against inlet guide vane outer platform and tool is held in position.

(10) Depress knob (4) and slowly turn clockwise or anti-clockwise, as required, to rotate I.P. system.

(11) On completion of system rotation, release pad (3) by unscrewing jack (2).

(12) Carefully withdraw turning tool from engine.

(13) Enter cold stream duct and pull master ram push rod fully rearward to move variable inlet guide vanes to minimum airflow position.

(14) Close pressure relief door in compressor section R.H. front fairing

(15) Remove working platform from cold stream duct.

(16) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00).

(17) Engines No.1 and 3

(a) Remove protective work mats or work platform from nose cowl air intake.

(18) Engine No.2

(a) Remove protective work mats from air intake.

(b) Close access doors 431AZ and 433BL.

B. Rotate I.P. System - Method 2

(1) Equipment required:

| | |
|---|---|
| UT.972 | Turning tool |
| XUT.40959 | Work platform, nose cowl |
| 289200 or C 4G 4342 | Protective work mats |

(2) Engines No.1 and 3

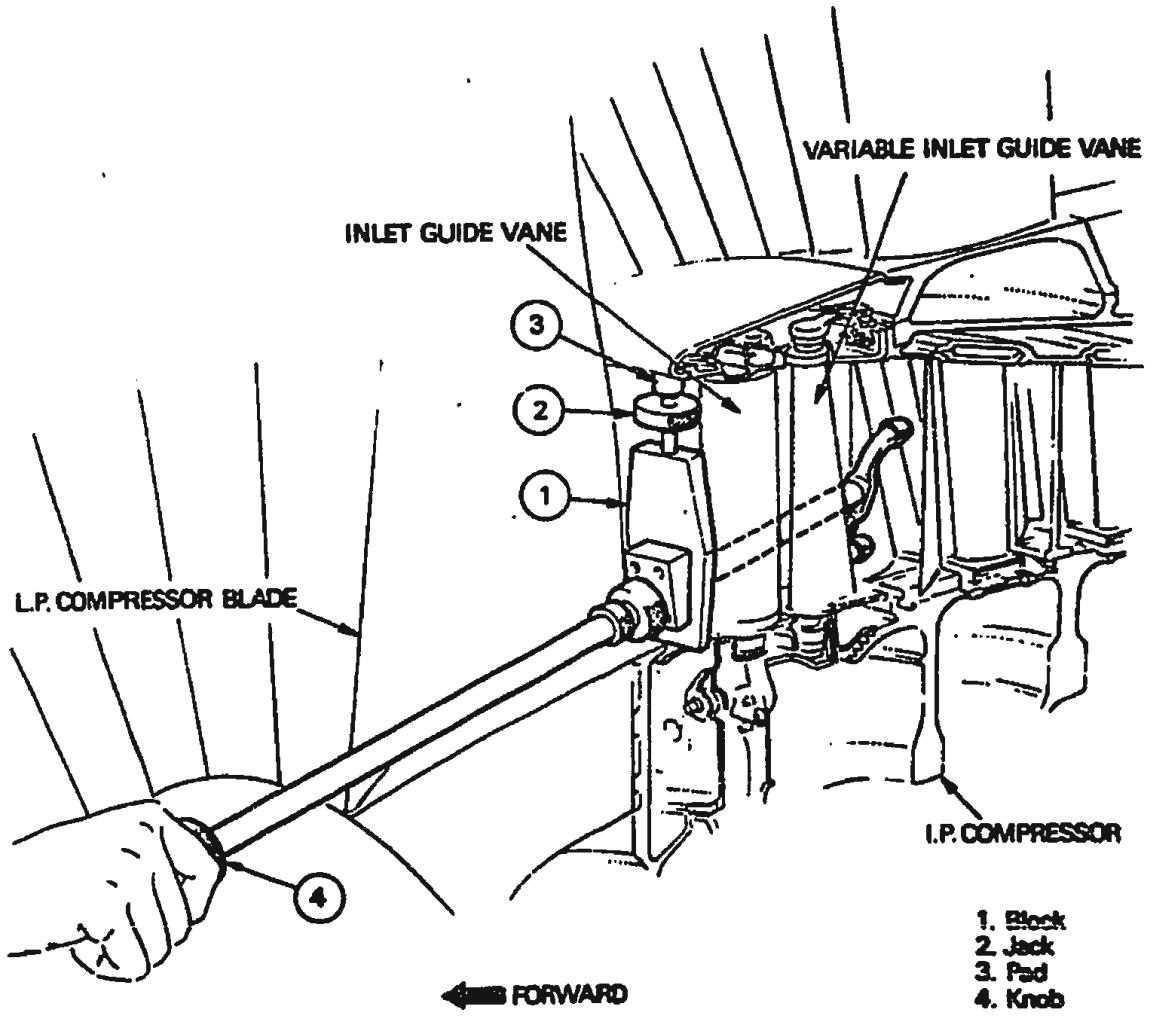
(a) Position protective work mats or work platform in nose cowl air intake ensuring red warning pennants are clearly visible from aircraft exterior.

(3) Engine No.2

(a) Open access doors 433BL and 431AZ.

(b) Position protective work mats in air intake ensuring red warning pennants are clearly visible from aircraft exterior.

(4) Enter air intake, carefully pass UT.972 turning tool, angled end first, through L.P. compressor blades, I.P. compressor inlet guide vanes and variable inlet guide vanes to locate on stage 1 I.P. compressor blades.




I.P. system hand turning tool
Fig.301

(5) Slowly rotate I.P. system, clockwise viewed from front.

(6) On completion of system rotation, remove turning tool from engine.

(7) Engines No.1 and 3

(a) Remove protective work mats or work platform from nose cowl air intake.

(8) Engine No.2

(a) Remove protective work mats from air intake.

(b) Close access doors 431AZ and 433BL.

3. Rotate Engine H.P. System

Service Bulletins referred to:

Teleflex S.B.28906-73-1 - Introduction of Baulking Peg for Hand Cranking Cover.

R S.B.72-4763 - Input Drive Bevel Gears Housing with Solid
R Inserts at Hand Turning Access Point.

Referenced Procedures

| | |
|---|---|
| 70-02-01 | Identification, Lubrication and Fitting of Rubber Sealing Rings |
| 71-11-00 | Cowlings, Engines No.1 and No.3 - Servicing |
| 71-12-01 | L.H. and R.H. Lower Hinged Cowl - Servicing |
| 76-11-00 | Engine Controls - Adjustment/Test |
| 80-11-07 | Pneumatic Starter - Removal/Installation |

Illustrated Parts Catalogue References

The I.P.C. sections where parts disturbed during the following operations can be located are as follows:

| | |
|---|---|
| 76-11-02 | Fuel Flow Regulator F.T.C.S. Box and Fittings |

Three methods of H.P. system rotation are described.

Method 1 uses a hand turning tool.

Method 2 uses power rotation.

Method 3 uses a hand turning tool and is used if the torque applied in Methods 1 or 2 appears likely to exceed 70 lb.ft.

A. Rotate H.P. system - Method 1

(1) Equipment required:

UT.977 Hand turning tool

(2) Open L.H. hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or lower L.H. cowl access door 433BL for engine No.2.

R (3) Refer to fig.302, on units not incorporating
R S.B.72-4763, remove bolts (8), washers (6) and cover (1).

R On units incorporating S.B.72-4763, remove bolts (8),
R washers (7) and (6) then cover (1).

(4) Insert hand turning tool UT.977 in bore of input drive housing ensuring correct engagement with splined end of starter drive gearshaft oil feed tube.

(5) CAUTION: MAXIMUM TORQUE TO BE APPLIED TO TOOL DURING TURNING OPERATION IS 70 LB.FT.
Slowly rotate H.P. system by turning hand turning tool clockwise or anti-clockwise, as required.

NOTE: If torque of 70 lb.ft. appears likely to be exceeded, refer to Method 3 for alternative turning procedure.

(6) On completion of system rotation, remove hand turning tool UT.977 from input drive housing.

(7) Fit and lubricate (Ref. 70-02-01) new seal ring to access cover (1).

(8) On fuel flow regulator boxes incorporating Teleflex
R S.B.28906-73-1, position access cover on fuel flow regulator box.

On fuel flow regulator boxes not incorporating
R Teleflex S.B.28906-73-1, position access cover on fuel flow regulator box, ensuring positive location of hollow dowel.

R (9) On units not incorporating S.B.72-4763, fit and secure
R washers (6) and bolts (8) to access cover (1).

R On units incorporating S.B.72-4763, fit and secure
R washers (6) and (7) and bolts (8) to access cover (1).

R (10) CAUTION: INCORRECT FITMENT OF THE ACCESS COVER ON THE FUEL FLOW REGULATOR BOX WILL RESULT IN OIL LEAKAGE.
Ensure access cover is a flush fit on the fuel flow regulator box.

R (11) Close L.H. hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or lower L.H. cowl access door 433BL for engine No.2.

B. Rotate H.P. system - Method 2

(1) Equipment required:

1702230 or 18911 - Turnover tool kit
Compressed air supply - max. press. 150 p.s.i.

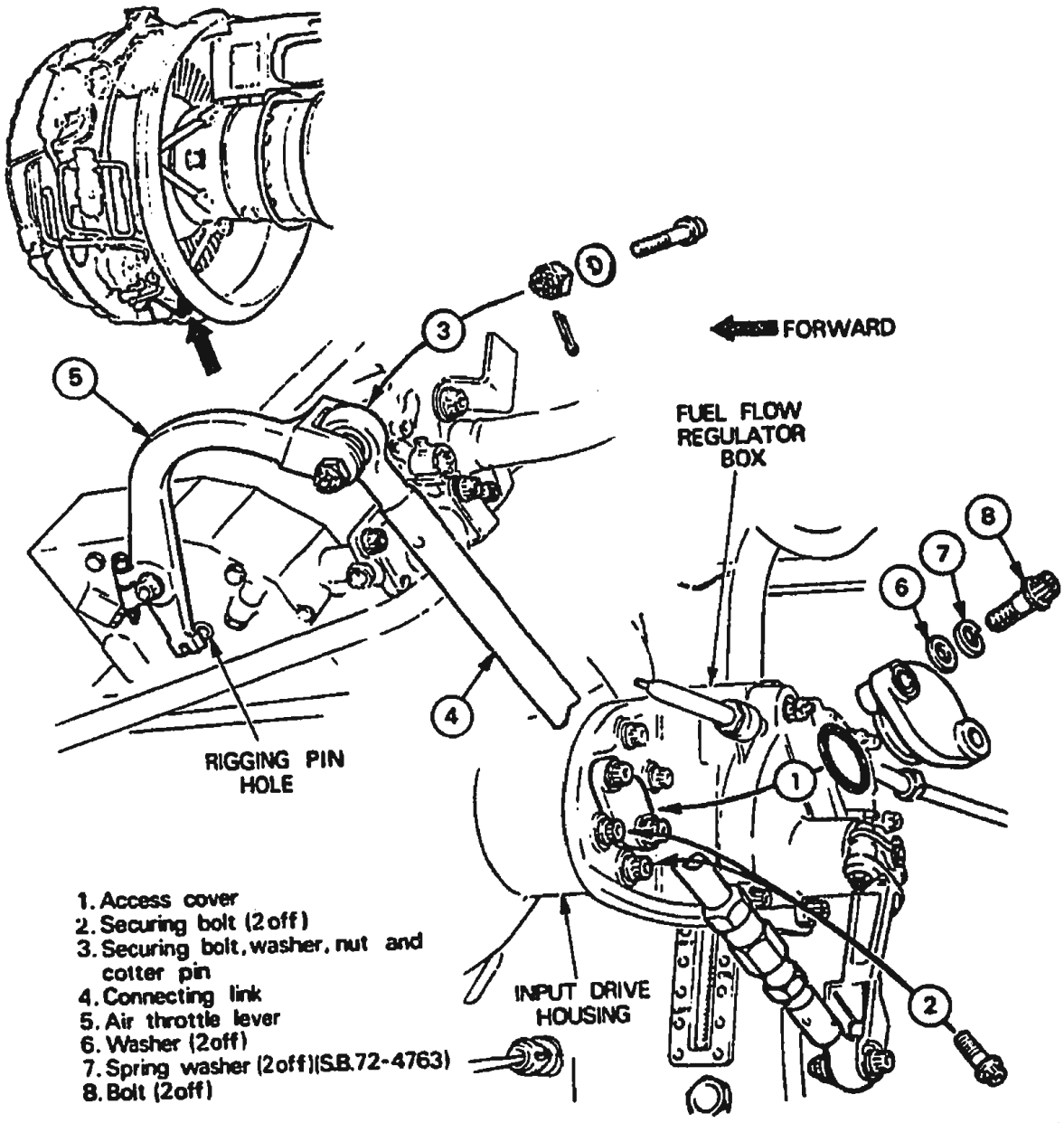
(2) Material required:

Line lubricator oil - SAE 10, non-detergent

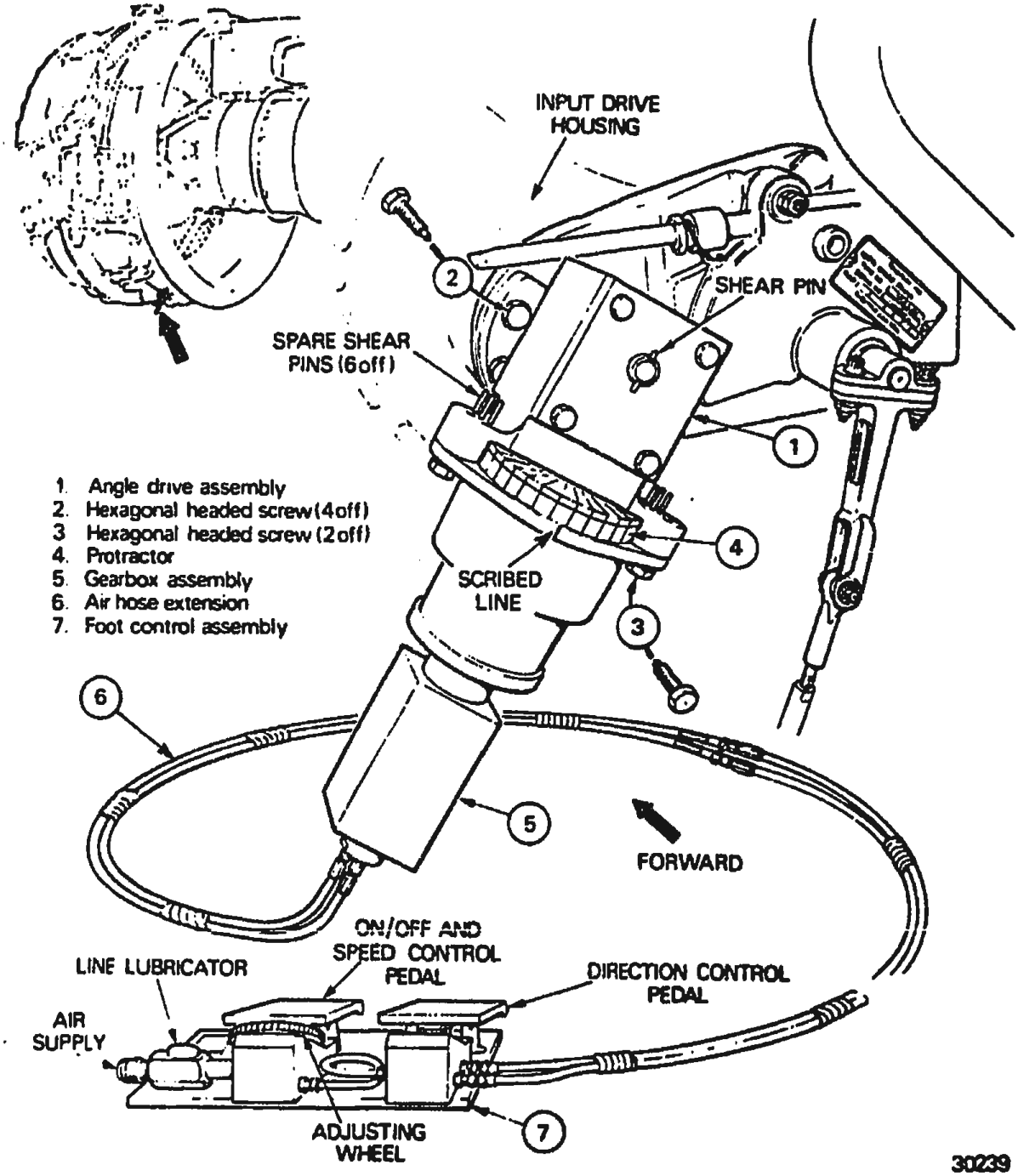
(3) Open L.H. hinged cowl 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

R (4) Refer to fig.302, on units not incorporating
R S.B.72-4763, remove bolts (8), washers (6) and cover
R (1).

R On units incorporating S.B.72-4763, remove bolts (8)
R washers (7) and (6), then cover (1).




R
R H.P. system rotation access point
Fig.302




H.P. system turnover tool kit
Fig.303

(5) Remove bolts (2).

(6) Remove cotter pin, nut, washer and bolt (3) and release connecting link (4) from air throttle lever (5).

(7) Refer to fig.303, insert angle drive assembly (1) in bore of input drive housing ensuring positive engagement with splined end of starter drive gearshaft oil feed tube. Secure with the hexagonal headed screws (2) retained in angle drive assembly mounting flange.

NOTE: A shear pin, fitted in the angle drive assembly, limits the maximum turning torque to 70 lb.ft. Ensure this shear pin is fitted before commencement of rotation.

(8) Remove hexagonal headed screws (3) in angle drive assembly: interpose protractor (4) aligning its zero degree mark with the scribed line on the gearbox assembly flange. Secure gearbox assembly (5) to angle drive assembly with hexagonal screws (3).

NOTE: Align protractor zero and scribed line prior to inspecting each subsequent H.P. system stage.

(9) Connect air hose extension (6) to gearbox assembly and air hose of foot control assembly (7).

(10) Connect line lubricator end of foot control assembly to air supply.

(11) Turn on air supply and operate foot controls to rotate H.P. system clockwise or anti-clockwise as required; frequently check oil level in line lubricator during operation by removing filler plug and visually inspecting. Replenish as necessary.

NOTE: If at commencement of or during engine rotation the shear pin breaks, fit a spare pin. If this also breaks, refer to Method 3 for alternative turning procedure.

Foot control operation - The foot pedal adjacent to the line lubricator controls on/off and regulates speed. Under the front section of this pedal is a large, knurled wheel. When a satisfactory H.P. system speed has been established, the wheel can be adjusted to control the downward travel of the pedal so enabling this speed to be kept constant. This adjustment lock can be quick-released by pushing down on the heel part of the pedal allowing the speed to be reduced or stopped. The other foot pedal controls the system direction of rotation by depressing either the toe or heel section. With the pedal in the neutral position, rotation is stopped.

Protractor use - The protractor has a 360 degree scale. Because of gear ratios the rotation of the protractor to the H.P. system is 1.0036:1. With the protractor set as in operation 3.B.(8), any blade position can be recorded for a 'second-look' by noting the degree reading on the protractor.

(12) On completion of system rotation, remove turnover tool kit ensuring the hexagonal headed screws (3) are replaced in the angle drive assembly.

(13) Refer to fig.302, fit and secure bolts (2).

(14) Fit and lubricate (Ref. 70-02-01) new seal ring to access cover (1).

R (15) On fuel flow regulator boxes incorporating Teleflex S.B.28906-73-1, position access cover on fuel flow regulator box.

R On fuel flow regulator boxes not incorporating Teleflex S.B.28906-73-1, position access cover on fuel flow regulator box, ensuring positive location of hollow dowel.

R (16) On units not incorporating S.B.72-4763, fit and secure
R washers (6) and bolts (8) to access cover (1).

R On units incorporating S.B.72-4763, fit and secure
R washers (6) and (7) and bolts (8) to access cover (1).

R (17) CAUTION: INCORRECT FITMENT OF THE ACCESS COVER ON THE FUEL FLOW REGULATOR BOX WILL RESULT IN OIL LEAKAGE.
Ensure access cover is a flush fit on fuel flow regulator box.

R (18) Fit connecting link (4) to air throttle lever (5) and secure with bolt, washer, nut and cotter pin (3).

R (19) Set engine power control linkage (Ref. 76-11-00).

R (20) Close L.H. hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01)

C. Rotate H.P. system - Method 3 (torque exceeds 70 lb.ft.)

(1) Equipment required:

UT.1067 Hand turning tool

(2) Engines No.1 and 3

(a) Open R.H. hinged cowl, 414A or 424A (Ref. 71-11-00).

(b) Disconnect electrical connector from stowage plug on No.1 hydraulic pump mounting face blanking cover.

(c) Remove four securing nuts, stowage bracket and withdraw blanking cover.

(3) Engine No.2

(a) Remove engine pneumatic starter (Ref. 80-11-07).

(4) CAUTION: MAXIMUM TORQUE TO BE APPLIED DURING TURNING OPERATION TO EITHER THE AIR STARTER OR NO.1 HYDRAULIC PUMP DRIVE SHAFT IS 400 LB.FT.
Insert hand turning tool in bore of hydraulic pump or starter motor drive shaft as appropriate and slowly rotate H.P. system by turning hand turning tool clockwise or anti-clockwise as required: remove tool after use.

(5) Engines No.1 and 3

(a) Fit and lubricate (Ref. 70-02-01) new seal ring to end of hydraulic pump drive shaft.

(b) Position blanking cover on hydraulic pump mounting face.

(c) Position stowage bracket on the two left-hand studs and secure cover with four nuts.

(d) Connect electrical connector to stowage plug.

(e) Close R.H. hinged cowl, 414A or 424A (Ref. 71-11-00).

(6) Engine No.2

(a) Install engine pneumatic starter (Ref. 80-11-07).

(7) Continue with operations 3.A. (6) through (10) or 3.B. (12) through (19) as appropriate.

## ENGINE - INSPECTION/CHECK

| Paragraph | Test Procedure |
|---|---|
| 1. | General |
| 2. | Equipment Preparation and Use |
| 3. | Inspect I.P. Compressor |
| 4. | Inspect I.P.2 Compressor Rotor Blade Platform |
| 5. | Inspect H.P. Compressor |
| 6. | Inspect Combustion Liner and H.P. Turbine Nozzle Guide Vanes |
| 7. | Inspect H.P. Turbine Blades and I.P. Turbine Blade Front Surface |
| 8. | Inspect I.P. Turbine Blade Rear Surface and L.P. Turbine Blades |
| 9. | Inspect Stage 2 and 3 L.P. Turbine Nozzle Guide Vanes |
| 10. | Lease Engine Receipt and Interchange Inspection |
| 11. | Engine Lease Termination Inspection |

Service Bulletins referred to:

S.B.72-2086 - Deletion of Ventilating Cooling Shroud and Fairing Seal.
S.B.72-2379 - Deletion of H.P. Nozzle Guide Vane with Borescope Access Features.
S.B.72-2588 - H.P. Turbine Case and Vanes - Introduction of Intrascope Facility.
S.B.72-2592 - Integral Intrascope Blanking Pin and Tube Bracket
S.B.72-2593 - Intrascope Plug with Reduced Length Stem.
S.B.75-2668 - Simplified Run of P.4 Air Tube from No.3 Fuel Spray Nozzle to I.G.V. Ram.
S.B.72-3310 - Compressor Intermediate Case - Introduction of a Steel Fabricated Case

S.B.78-3551 - Introduction of 15 Degree Afterbody
S.B.72-3701 - H.P.1 Borescope Access Hole Deleted
S.B.72-3783 - H.P. Compressor - Re-located and Rounded Cases
S.B.72-3902 - Introduction of H.P.1 access hole
S.B.72-4834 - H.P./I.P. Turbine Case - Deletion of redundant vibration transmitter mount.
S.B.77-4644 - Vibration Indication System - Repositioned vibration transmitter.
S.B.77-5387 - Introduction of revised vibration monitoring system.
S.B.72-5276 - Rationalisation of bolts attaching the transducer and intrascope access plug mounting bracket (Special Order Only).
R S.B.72-5854 - Introduction of I.P. compressor intrascope blanking
R plug with barrel profile.

## 1. General

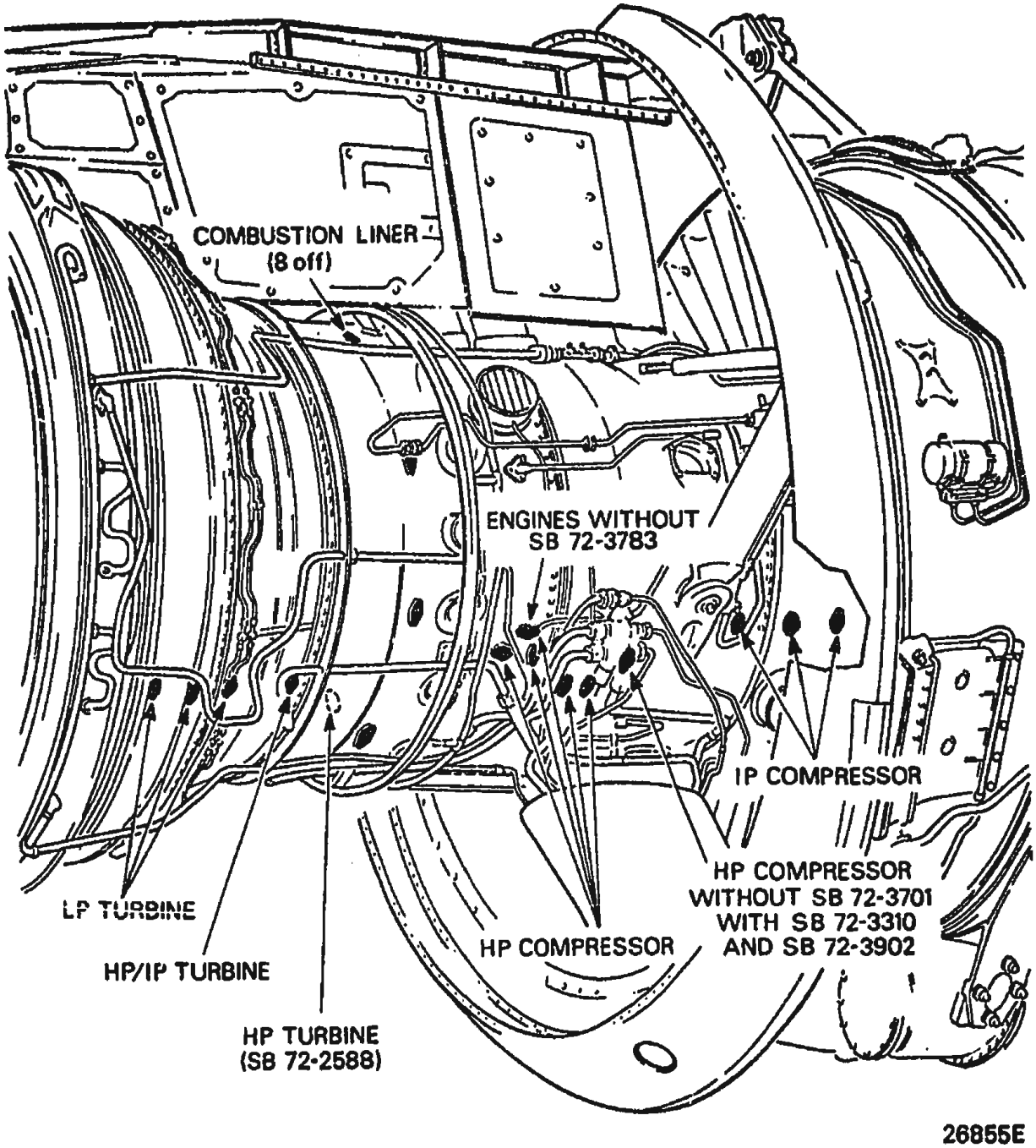
A. Provision is made at various positions on the gas generator (Ref. fig.601) for the use of borescope inspection equipment to facilitate visual examination of the compressor and turbine rotors blades, the combustion liner interior and the H.P. nozzle guide vanes.

B. The inspection equipment (Ref. fig.602) comprises a 110V/250V A.C. light box whose output is transmitted to the probe viewing instrument by a flexible, fibre light cable. To enable the various areas of the engine to be effectively inspected, a range of three probes is provided. Still photographs can be taken through the probe eyepiece using the available light source.

C. On engines incorporating S.B.72-2379, inspection of the H.P. turbine blade leading edge is achieved by positioning a guide tube in a combustion section blanking plug port and using additional inspection equipment (Ref. fig.603). This equipment comprises a 115V A.C. light box whose output is transmitted through a flexible light connecting bundle to a flexible borescope positioned in the guide tube.

D. On engines incorporating S.B.72-2588, inspection of the H.P. turbine blade leading edge is achieved using the inspection equipment illustrated in fig.602.

E. The borescope blanking plugs are identified on the appropriate illustrations by a reference in parenthesis to the Illustrated Parts Catalogue (I.P.C.) figure/item number (e.g. 72-00-03, 01-400). Alpha variants of this number will not be quoted.




R Location of borescope access ports
R Fig.601

2. Equipment Preparation and Use

A. Inspection equipment - NDT (Ref. fig.602)

(1) Equipment required:

| | |
|---|---|
| 1702196 | Case (NDT No.CC/1) |
| or | |
| 1702381 | Case (NDT No.CC/3) |
| 1702228 or 1702322 | Light source box (NDT No. LSB/110/250) or (NDT No. LSB/05/150) |
| 1702227 | Fibre light guide cable (NDT No.FLGC/10/5A) |
| Endoprobe - as required | |

Additional equipment, if required:

| | |
|---|---|
| 1702225 | Photographic adapter (NDT No.PA/1/211) |
| 1702232 | Camera (NDT No.EXA/100) |
| 1702233 | Camera case (NDT No.CAM/C1) |

(2) Remove light source box cover and ensure switch located inside box is selected to correct supply voltage.

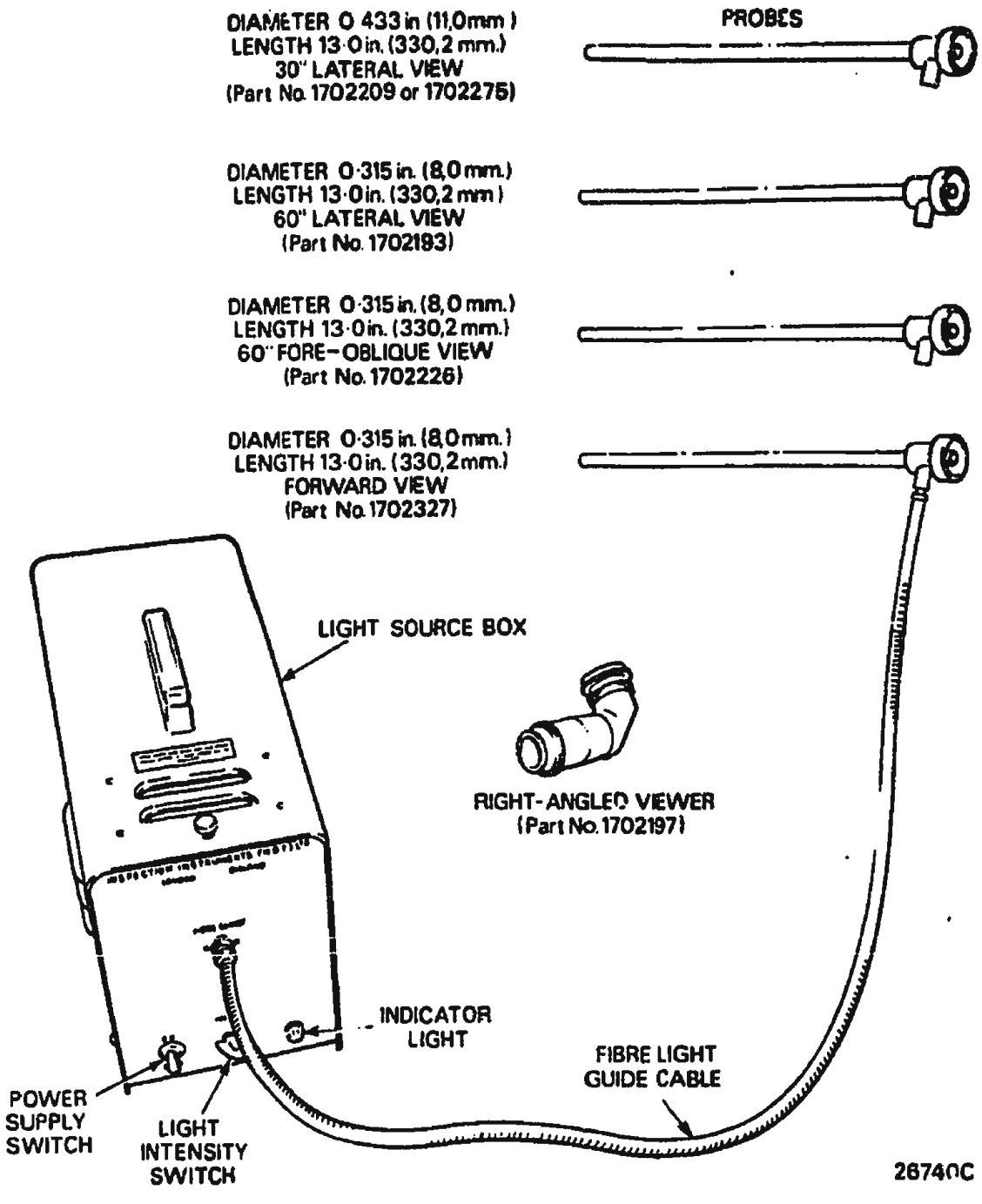
(3) Refit cover then connect box to electrical supply.

(4) Turn intensity switch to lowest light position.

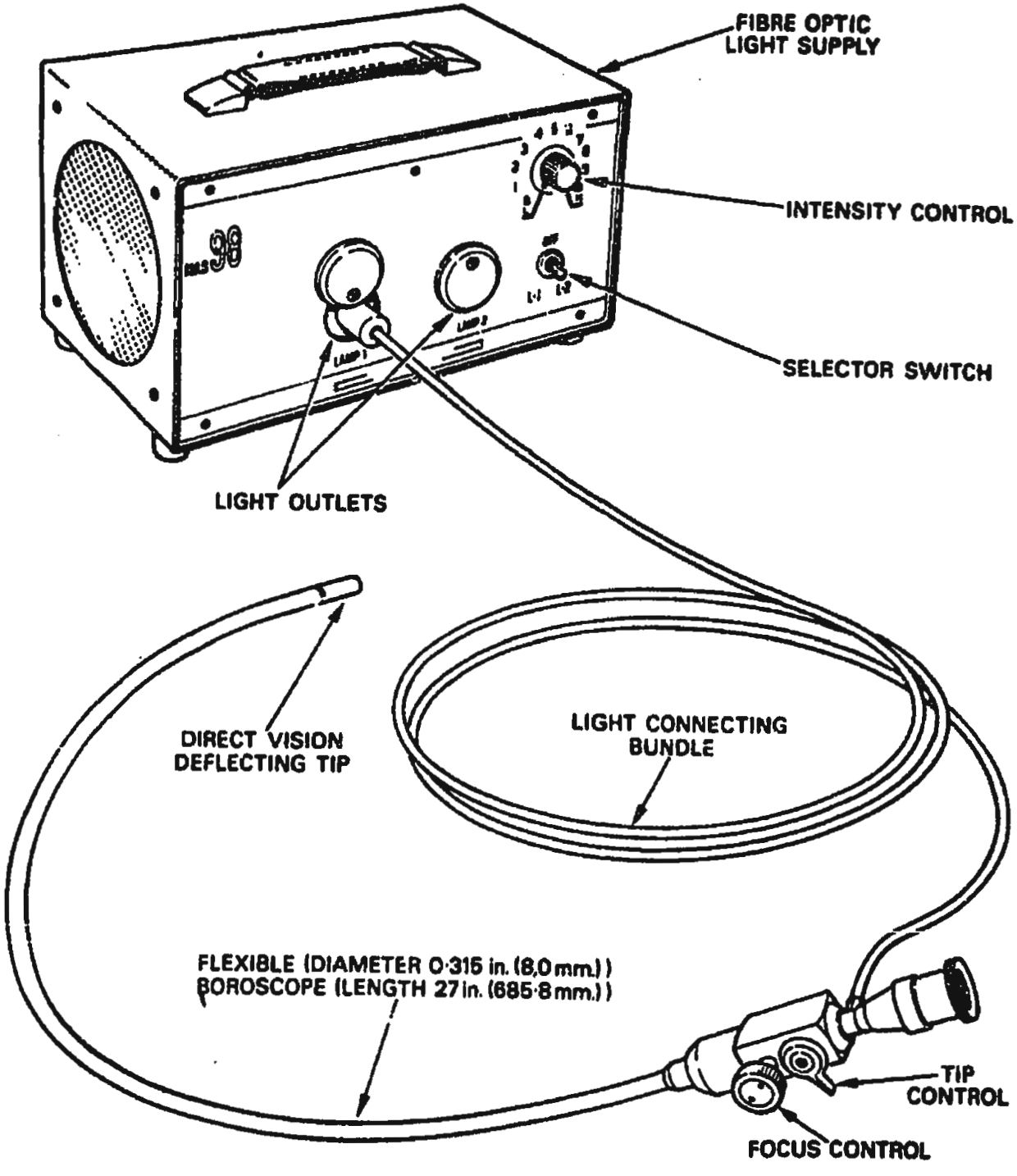
(5) Select power supply switch ON and check that red indicator light is illuminated.

(6) Assemble light cable and appropriate probe to light source box, enter probe into engine at required position (Ref. para 3 through 7). Turn intensity switch to obtain optimum illumination and carry out inspection varying the depth of probe insertion consistent with component examination required.

NOTE: When looking through probe eyepiece, direction of viewing is indicated by a small nick in periphery of lens.




Inspection equipment - NDT
Fig.602




Inspection equipment - ACMI
Fig.603

(7) On completion of inspection, withdraw probe, select power supply switch OFF allowing 30 seconds for bulb filament to cool before moving light source box, then disassemble equipment.

B. Inspection equipment - ACMI (Ref. fig.603) - Engines incorporating S.B.72-2379

(1) Equipment required:

| | |
|---|---|
| 1702223 | Light connecting bundle (ACMI No.FO-400-SA) |
| 1702224 | Fibre optic light supply (ACMI No.BLS98) |
| R 1702243 | Flexible borescope (ACMI No.BFOF3127DD) |

(2) Connect light supply to electrical supply.

(3) Move cover to expose light outlet (1 or 2 as required) and plug in light connecting bundle.

(4) Set intensity control to zero.

(5) Move selector switch from OFF to appropriate light outlet position.

R (6) Assemble light bundle to borescope and enter borescope into combustion section (Ref. para.5). Turn intensity control to obtain optimum illumination noting that settings above position 8 provide boosted light output but shorten lamp life. Carry out
R inspection utilizing borescope tip and focus controls as necessary.

NOTE: If due to light supply bulb failure, alternative light outlet is required for use, repeat operations 3 to 7.

R (7) On completion of inspection, withdraw borescope, position selector switch to OFF then disassemble equipment.

## 3. Inspect I.P. Compressor

A. The following operations detail I.P. compressor inspection procedures; Stage 1 is inspected through the front of the engine while Stages 2 to 7 are inspected using borescope equipment. For specific component inspection and associated acceptance standards refer to 72-32-00, Inspection/Check.

C NOTE: For AVM problems it is not necessary to borescope the
C IP compressor.

B. WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref. 78-30-00, Servicing).

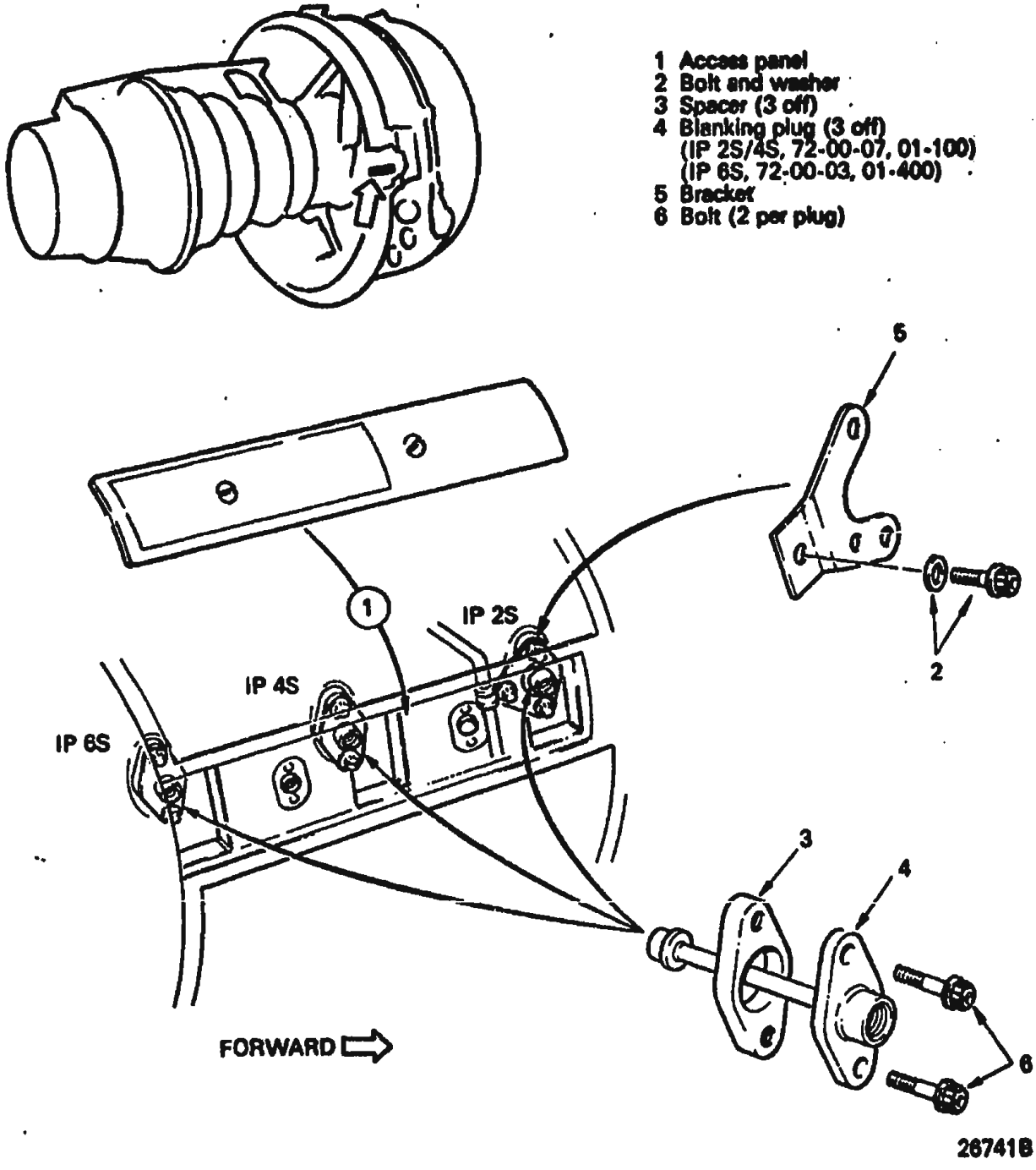
C. Equipment required:

| | |
|---|---|
| 289200 or C 4G 4342 | Protective work mats |
| HU.19036 | Impact extractor |
| 1702193 | Endoprobe (NDT No./08/V90 deg./325) |
| R or | |
| R 1702374 | Endoprobe |
| 1702226 | Endoprobe (NDT No.08/V60 deg./325) |
| R or | |
| R 1702375 | Endoprobe |
| 1702197 | Right-angled viewer (NDT No.Z/RA) |

Clean, stiff-bristled brush (jointing compound)

D. Materials required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid Methylethylketone (M.E.K.) | B.S.1940: 1968 | - | 135 |
| or Acetone | B.S.509: 1964 | - | 150 |
| or Methylene Chloride (Dichloromethane) | B.S.1994: 1953 | - | 169 |




R I.P. compressor borescope access
R Fig.604

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Jointing compound | DTD.900/4586 Hylomar PL32 (light) | - | 4/46 |

E. Position protective work mats in cold stream duct.

F. Fit I.P. system turning tool (Ref. 72-00-00, Servicing).

G. Refer to fig.604, remove access panel (1) in compressor section front R.H. fairing (412BR, 422BR or 432BR).

H. Assemble inspection equipment (Ref. para. 2.A.) using probe 1702193 or 1702374 and, if required, probe 1702226 or 1702375 for blade root inspection. Use right-angled viewer with either probe as necessary.

J. Inspect Stage 1 I.P. Compressor Blades

(1) Using an inspection lamp positioned in the air intake, rotate I.P. system (Ref. 72-00-00, Servicing) and inspect stage 1 I.P. compressor blades.

K. Inspect Stage 2 and 3 I.P. Compressor Blades.

(1) Refer to fig.604, at I.P.2S position remove bolt and washer (2), bolts (6) and bracket (5) then using impact extractor, remove blanking plug (4) and spacer (3).

(2) Carefully insert probe with viewing aperture facing forward, rotate I.P. system (Ref. 72-00-00, Servicing) and inspect rear surface of stage 2 I.P. compressor blades; turn probe through 180 degrees and and inspect front surface of stage 3 I.P. compressor blades.

(3) Withdraw probe.

R (4) On engines with S.B.72-5854, with borescope blanking
R plug removed, inspect for wear.

(5) If non-routine eddy current inspection of I.P. compressor stage 2 blade inner platforms is required, carry out operations detailed in para.4.

(6) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION. AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Cold liquid degrease both surfaces of spacer (3) and mating faces of blanking plug (4) and compressor case; allow to dry.

(7) Brush apply a thin coat of jointing compound to both surfaces of spacer and also to mating faces of blanking plug and compressor case; allow compound to dry for a minimum period of 10 minutes.

(8) CAUTION: ENSURE BLANKING PLUG IS CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
Position spacer on compressor case, fit blanking plug then position bracket (5) on blanking plug and secure (Ref. 70-51-00) with bolts (6).

NOTE: If a blanking plug incorporating S.B.72-2593 is fitted, shorter securing bolts are used.

(9) Fit and secure bolt and washer (2).

L. Inspect Stage 4 and 5 I.P. Compressor Blades

(1) Refer to fig.604, at I.P.4S position remove bolts (6) and using impact extractor remove blanking plug (4) and spacer (3).

(2) Carefully insert probe with viewing aperture facing forward, rotate I.P. system (Ref. 72-00-00, Servicing) and inspect rear surface of stage 4 I.P. compressor blades; turn probe through 180 degrees and inspect front surface of stage 5 I.P. compressor blades.

(3) Withdraw probe.

R (4) On engines with S.B.72-5854, with borescope blanking
R plug removed, inspect for wear.

(5) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION. AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Cold liquid degrease both surfaces of spacer (3) and mating faces of blanking plug and compressor case; allow to dry.

(6) Brush apply a thin coat of jointing compound to both surfaces of spacer and also to mating faces of blanking plug and compressor case.

(7) CAUTION: ENSURE BLANKING PLUG IS CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
Position spacer on compressor case and fit blanking plug; secure (Ref. 70-51-00) with bolts (6).

NOTE: If a blanking plug incorporating S.B.72-2593 is fitted, shorter securing bolts are used.

M. Inspect Stage 6 and 7 I.P. Compressor Blades

(1) Repeat operation L.(1) at I.P.6S position.

(2) Carefully insert probe with viewing aperture facing forward, rotate I.P. system (Ref. 72-00-00, Servicing) and inspect rear surface of stage 6 I.P. compressor blades; turn probe through 180 degrees and inspect front surface of stage 7 I.P. compressor blades.

(3) Withdraw probe.

(4) On engines with S.B.72-5854, with borescope blanking plug removed, inspect for wear.

R (5) Repeat operation L.(5), (6) and (7) at I.P.6S position.

N. Disassemble inspection equipment (Ref. para.2.A.) and remove I.P. turning tool (Ref. 72-00-00, Servicing).

P. Fit and secure access panel (1) in compressor section front R.H. fairing (412BR, 422BR or 432BR).

Q. Remove protective work mats from cold stream duct.

R. Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

## 4. I.P. Compressor Stage 2 Blade Platform - Eddy Current Inspection

A. The following procedures describe non-routine eddy current inspection of I.P.2 compressor blade platforms to detect fatigue cracks on the platform radius of the convex airfoil.

NOTE: 1. Fig.604A illustrates typical crack location.

2. This inspection is difficult and requires experienced eddy current inspectors who have been extensively trained on the mock-up and then on the engine, and have acquired the 'feel' to correctly position the probe and obtain a clean scan.

B. Equipment Required:

(1) Eddy Current Unit

(a) Nortec NDT 25 (preferred) or

(b) Nortec NDT 15

(2) Probe Assembly

(a) Nortec SPO-1641B

(3) Calibration Standard

(a) Calibrated blade - I.P.2 blade with elox slot (ECM) 0.040 inch (1,016 mm.) long x 0.020 inch (0,508 mm.) deep x 0.004 inch (0,101 mm.) wide, positioned approximately half-way along the blade in the platform at the platform to airfoil radius, see fig.604B.

(b) Mock-up of the I.P. casing with borescope hole, stator and rotor blades including the calibration blade, see figs.604C and 604D.

(4) I.P. compressor turning tool (Ref. 72-00-00, Servicing).

C. Calibration Procedure

(1) Connect probe lead to instrument.

(2) Connect probe remote null and erase (if used).

(3) Connect mains electrical supply or batteries if relevant.

(4) Switch ON and allow 10 to 15 minutes for instrument to warm up and stabilise.

(5) Adjust instrument controls to the following settings:

| Control | Nortec NDT25 | Nortec NDT15 |
|---|---|---|
| Frequency | 2 MHz | 2 MHz |
| H Sensitivity | 2 V/Div | 2 V/Div |
| V Sensitivity | 0.2 V/Div | 0.5 V/Div |
| Gain | 50 | 50 |
| Store/Non-store | Store | Store |
| Display | H/V | N/A |
| Filter | 0 | N/A |
| Alarm | Off | N/A |

(6) Viewing mock-up standard with heavy plate vertical and to the right, start initial insertion of probe into
R borescope access hole with the probe held at 7 o'clock position - see fig.604E.

Whilst inserting the probe further into access hole past the stator vanes, twist probe counter clockwise simultaneously moving handle up towards level of
R borescope access hole, keeping the contoured probe shoe below and forward of the blade trailing edge. Continue movement until shoe is located in platform airfoil radius.

R The probe handle will now be located approximately 1.0in.
R (25,4 mm.) from the borescope hole, and will have rotated approximately 200 degrees from initial insertion position (see figs.604F and 604G).

(7) Maintaining a positive counter clockwise pressure on the probe handle traverse radius of blade platform for the best 'feel' and location to establish a suitable null point away from edges of ECM slot.

NOTE: Traversing critical area of blade platform will result in probe and handle moving approximately 0.625 inch (15,9 mm.) in and out
R or borescope access hole.

(8) Hold probe steady after establishing its position as in para.(7) and erase trace and null. Centralise spot, push probe handle slightly to the left in order to lift probe from blade platform surface then repeat and adjust phase angle so that spot moves from centre horizontally to the left. Check positioning, 'feel', and 'lift off', until a good repeatable 'lift off' signal is achieved.

(9) Traverse probe across ECM slot, if set up is correct, a vertical signal (NDT25) or angled signal (NDT15) approximately 50 degrees, will rise up from the 'lift off' base line. The required vertical amplitude of these signals is as follows:

(a) NDT25 - 30% ± 5% of full scale deflection (f.s.d.) equal to 3 major divisions.

(b) NDT15 - 20% ± 5% of f.s.d. equal to 2 major divisions.

(10) Adjust GAIN control to achieve required signal, refer to fig.604H for typical responses.

(11) The equipment is now calibrated for inspection.

R D. Inspect I.P. Stage 2 Blade Platforms

(1) The I.P. compressor must be rotated to position the blade being inspected as shown in fig.604I, use a turning tool detailed in 72-00-00, Servicing, page block 301.

R (2) Insert probe through borescope access hole and locate on blade platform. Use the same technique described in calibration procedure paras.C.(7) and (8).

(3) Scan radius of each blade platform

NOTE: If necessary repeat scans and nulls to achieve a satisfactory 'lift off' trace signal.

R (4) Carry out this inspection on all 49 blade platforms.

R (5) Return engine to flight status Ref.paras.3.N. to
R R.

E. Acceptance Standard

(1) Any positive repeatable crack-like indication observed, equal to or greater than the signal of the calibrated slot - Reject blade.

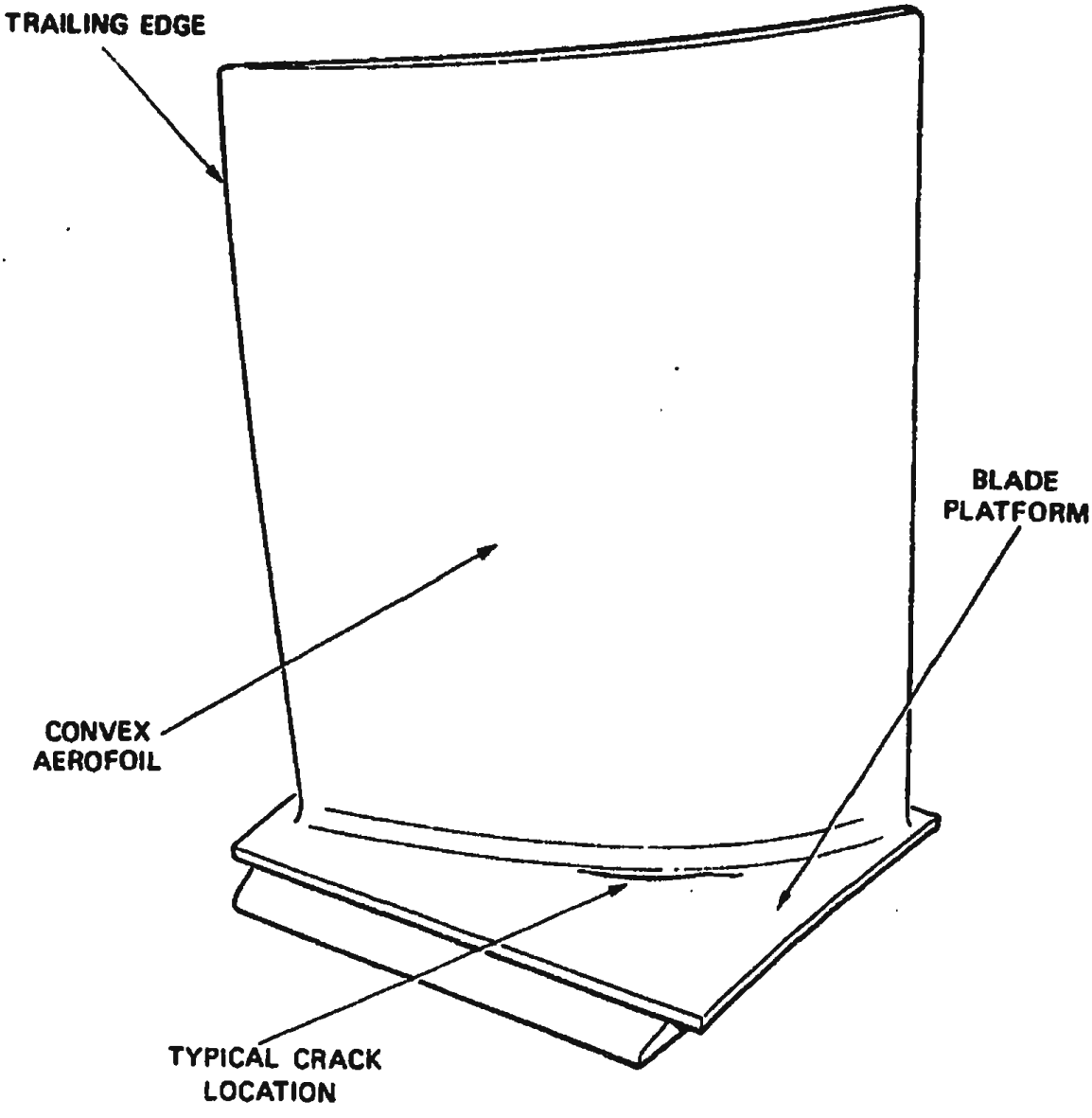
F. Equipment Suppliers

(1) Eddy Current Units and Probe Assembly:

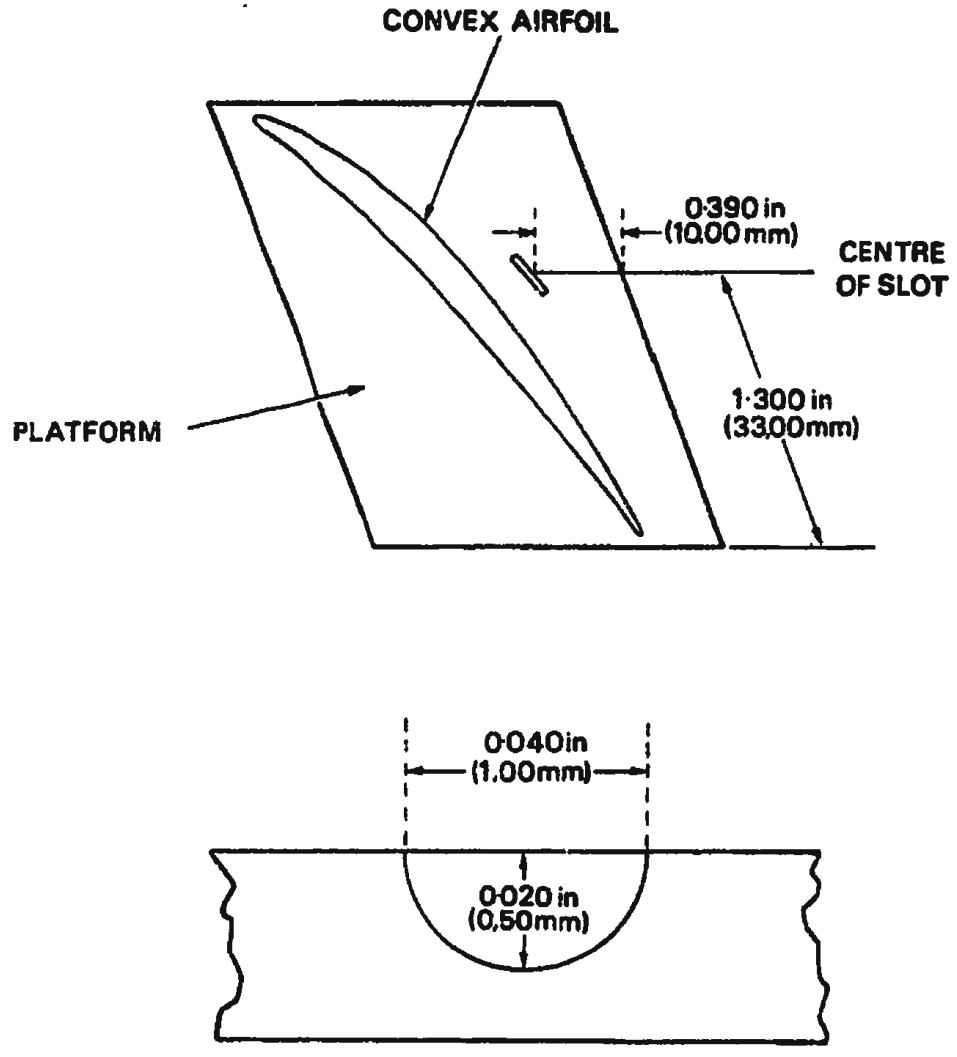
Nortec Corporation,
421, North Quay,
Kennewick,
Washington 99336,
USA

(2) Calibration Standard (ECM slotted blades) can be produced in blades supplied to:

Electro-Form Machining Co.,
Fort Lauderdale,
Florida,
USA



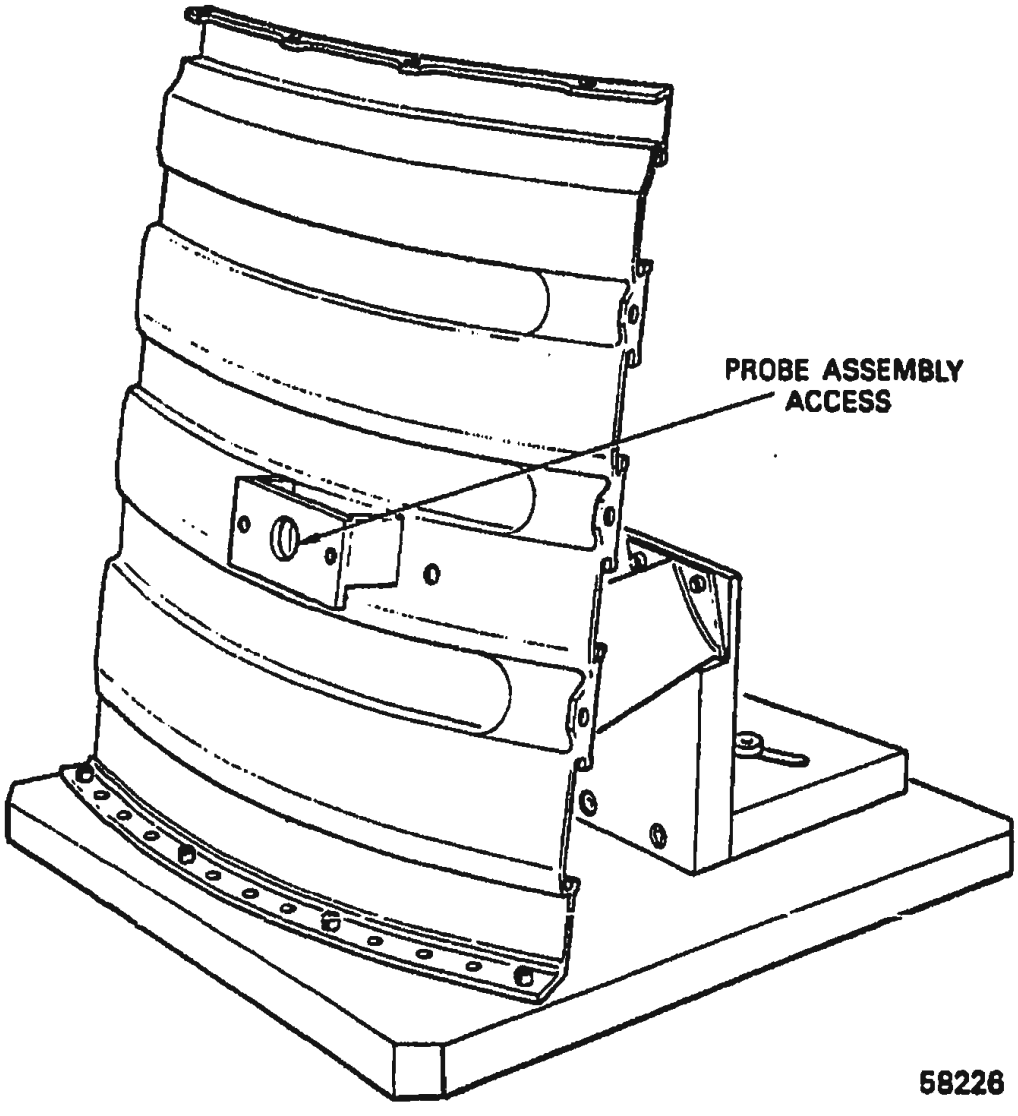

I.P.2 Blade - Typical Crack Location
Fig.604A



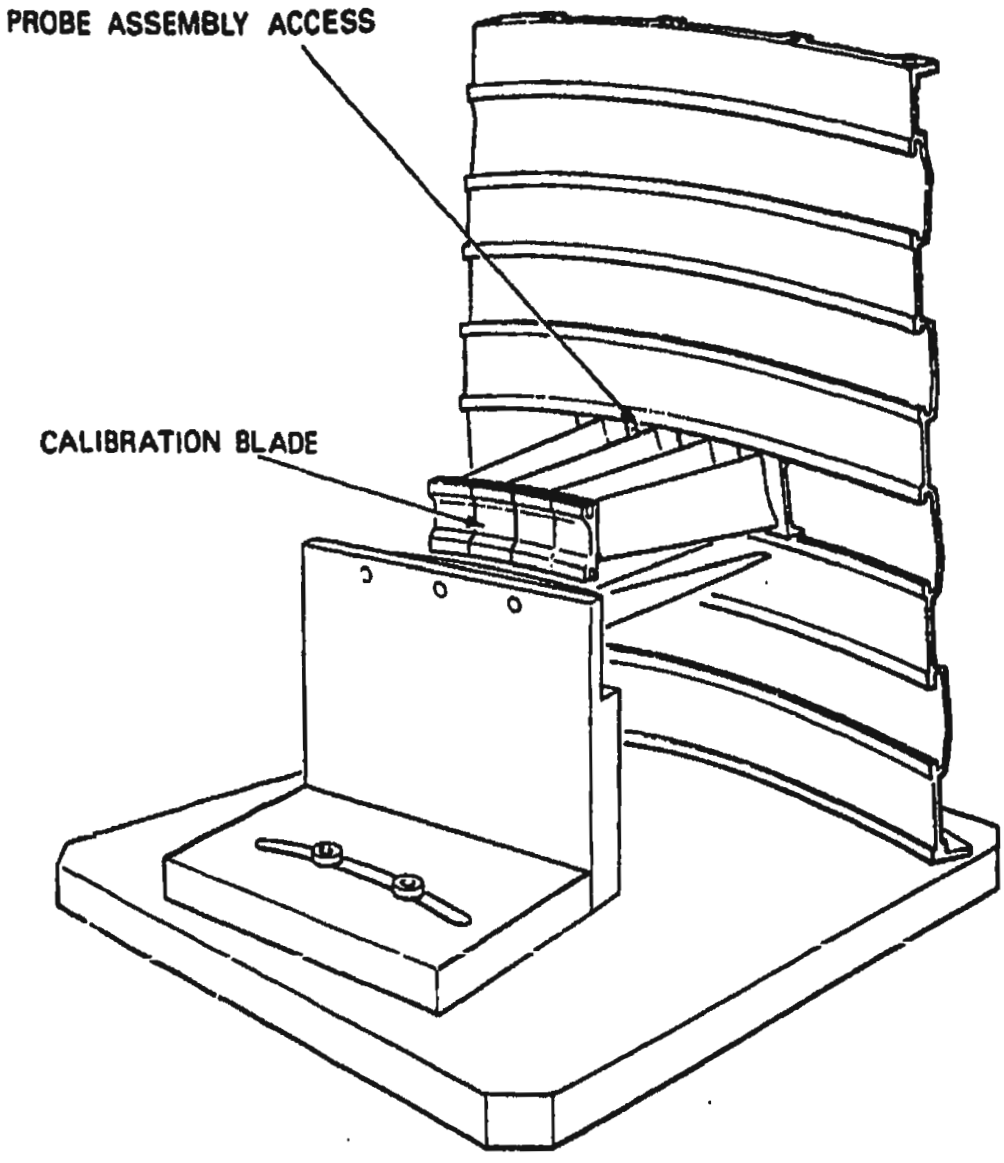

SLOT DIMENSIONS

58225

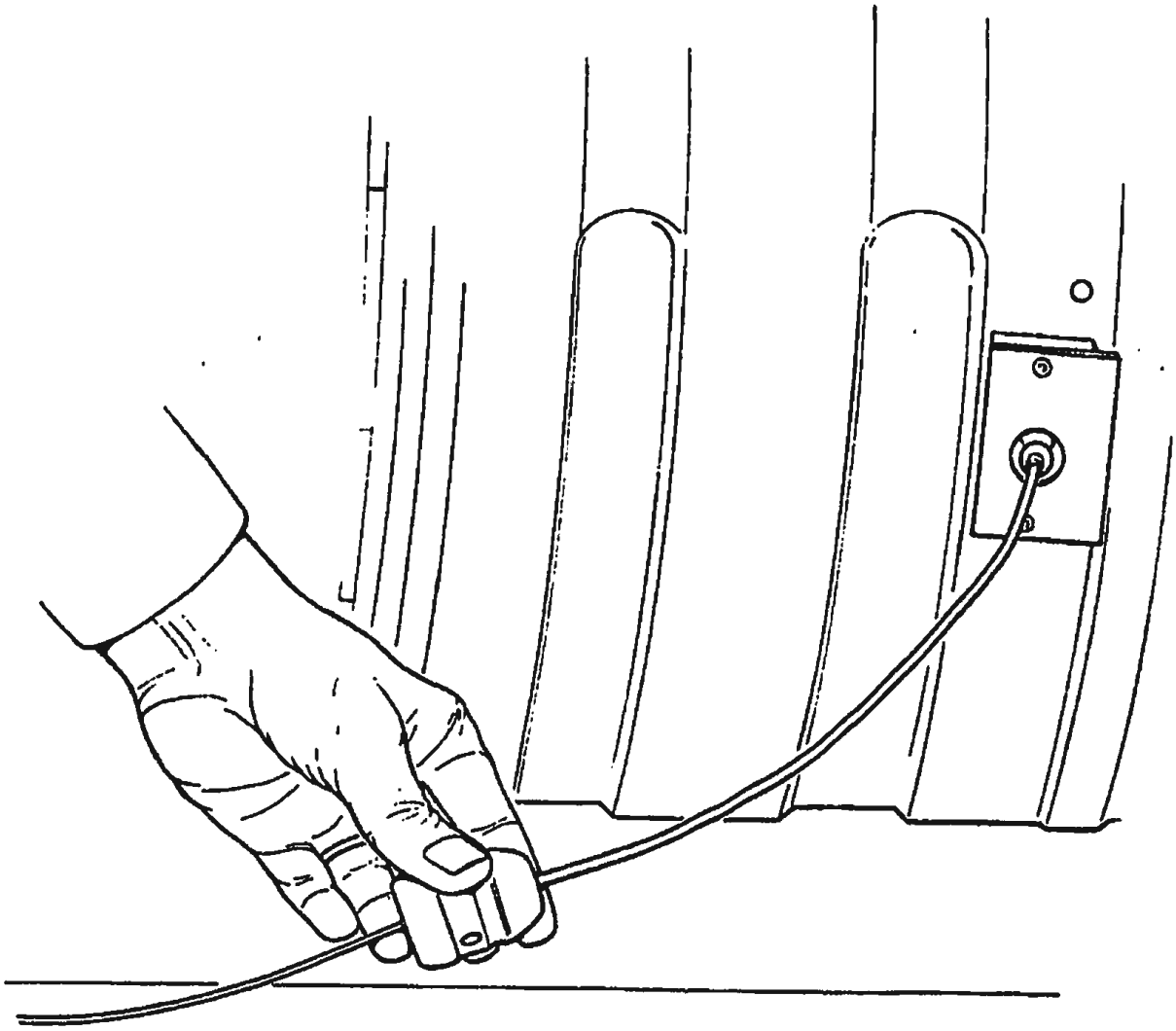
I.P.2 Blade - Calibration Standard
Fig.604B




I.P. Casing Mock-up - Eddy Current Probe Assembly Access
Fig.604C

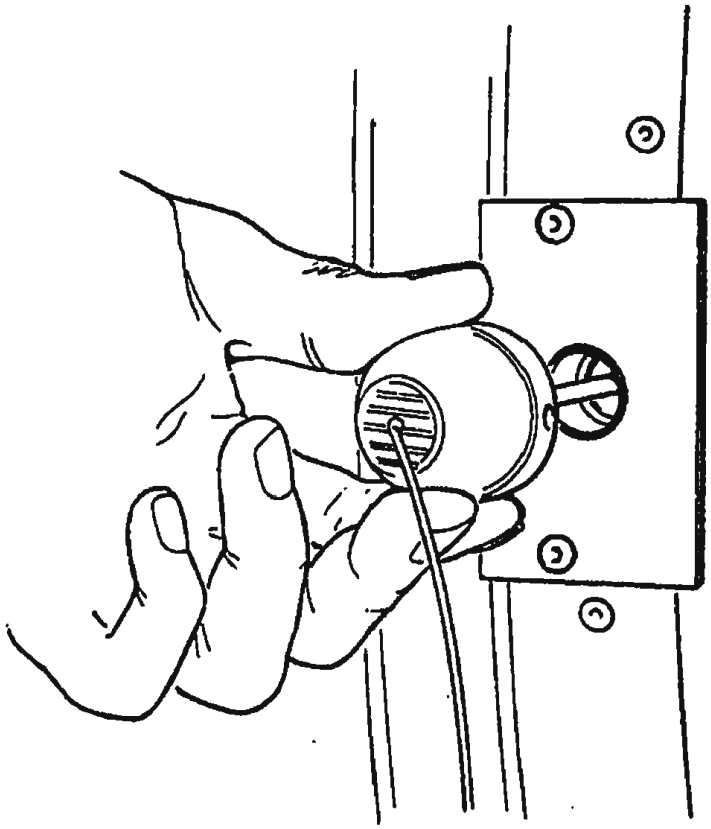



I.P. Casing Mock-up - Calibration Blade
Fig.604D



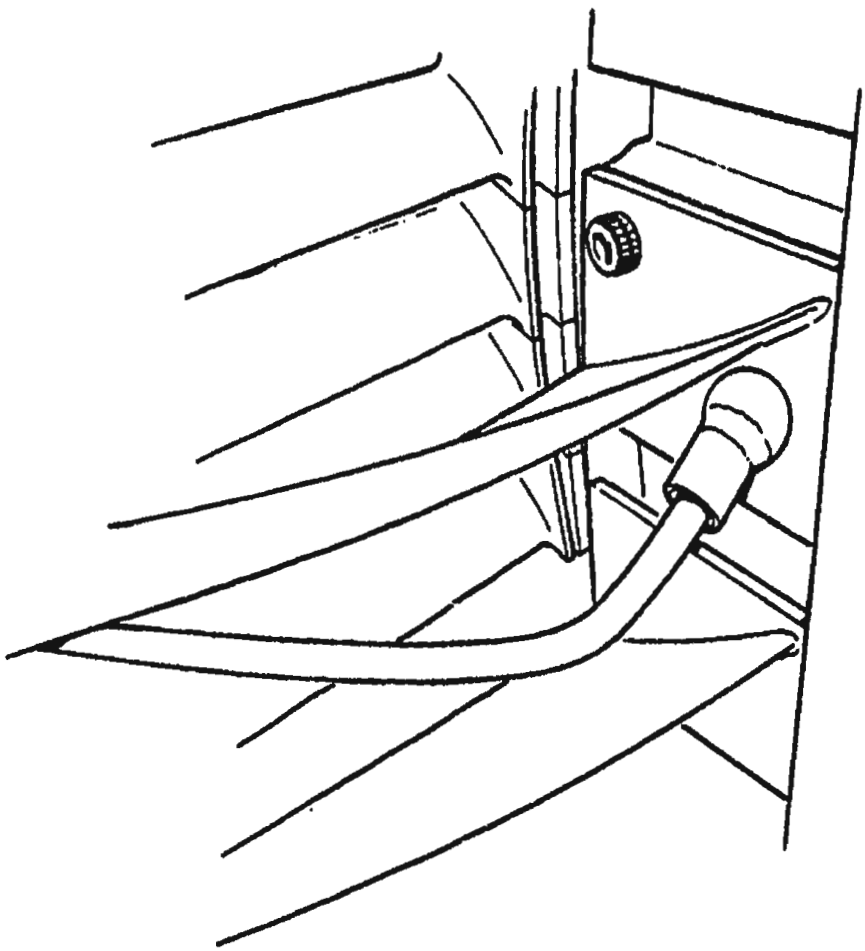
58228

Eddy Current Probe Position - Initial Insertion
Fig.604E



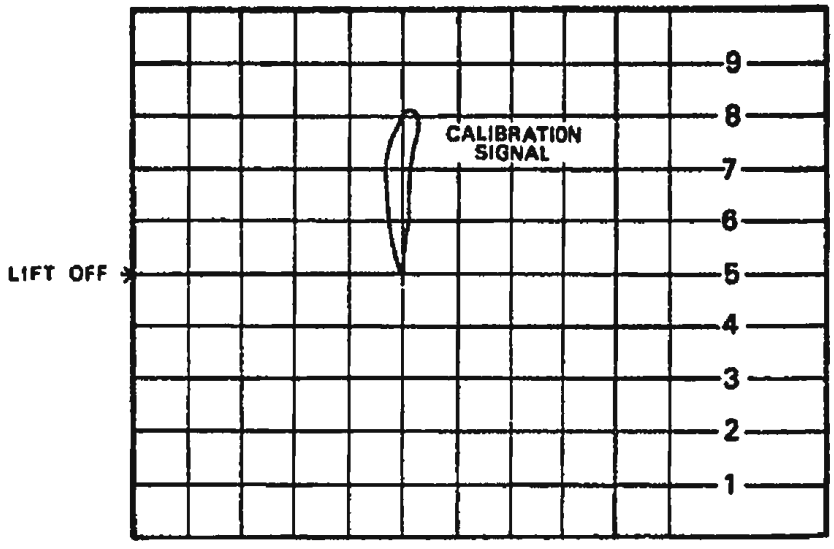
58229

Eddy Current Probe Located in Platform Airfoil Radius - External View
Fig.604F

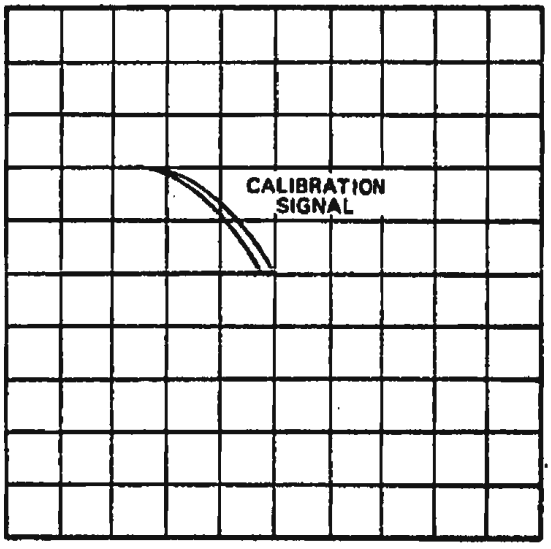


58230

Eddy Current Probe Located in Platform Airfoil Radius - Internal View
Fig.604G



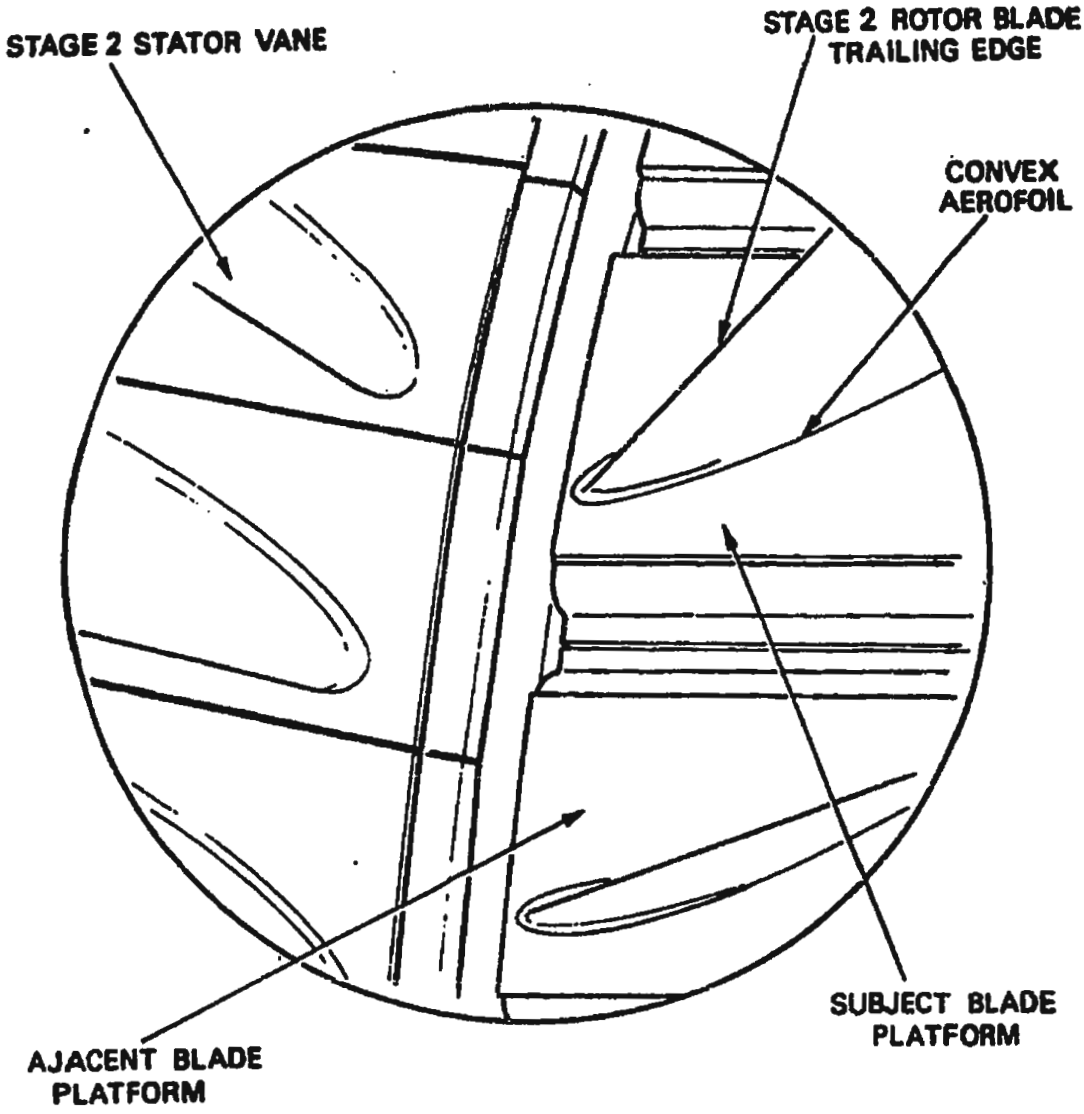

NORTEC NDT 25




NORTEC NDT 15

58231

Typical Calibration Blade Scan Signal
Fig.604H




VIEW THROUGH I.P.2S BOROSCOPE ACCESS

58232

Positioning of Stage 2 Blades for Eddy Current Inspection
Fig.604I

5. Inspect H.P. Compressor

A. The following operations detail H.P. compressor borescope inspection procedures. For specific component inspection and associated acceptance standards refer to 72-34-00, Inspection/ Check.

C C NOTE: For AVM problems, it is only necessary to inspect HP compressor Stage 5 and 6 (see 5.N.).

B. WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref. 78-30-00, Servicing).

C. Equipment required:

| | |
|---|---|
| 289200 or C 4G 4342 | Protective work mats |
| HU.19036 | Impact extractor |
| 1702193 | Endoprobe (NDT No.08/V90 deg./325) |
| or | |
| 1702374 | Endoprobe |
| 1702226 | Endoprobe (NDT No./08/V60 deg./325) |
| or | |
| 1702375 | Endoprobe |
| Small, clean brush (dry film lubricant) | |

D. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | B.S.4487: 1969 | Mil-T-81533 | 1/21 |
| Dry film lubricant | PL198 | - | 4/20 |
| R R Jointing compound | Silkolene 762 (SQ2) | - | 423 |
| Lockwire | DTD.189A 22 S.W.G. | - 21 A.W.G. | 238 |

E. Fit H.P. system turning tool (Ref. 72-00-00, Servicing).

F. Position protective work mats in cold stream duct.

G. Remove access panel in compressor section rear R.H. fairing (412FR, 422FR or 432FR).

H. Assemble inspection equipment (Ref. para.2.A.) using probe 1702193 or 1702374 and, if required, probe 1702226 or 1702375 for blade root, platform and lockplate inspection.

J. Inspect Stage 1 H.P. Compressor Blades - engines without S.B.72-3701 or engines with S.B.72-3310 and S.B.72-3902.

(1) Refer to fig.605, at H.P.1R position remove bolts (1) and using impact extractor, remove sealing tube (2).

(2) Carefully insert probe with viewing aperture facing rearward, rotate H.P. system (Ref. 72-00-00, Servicing) and inspect front surface of stage 1 H.P. compressor blades.

(3) Withdraw probe.

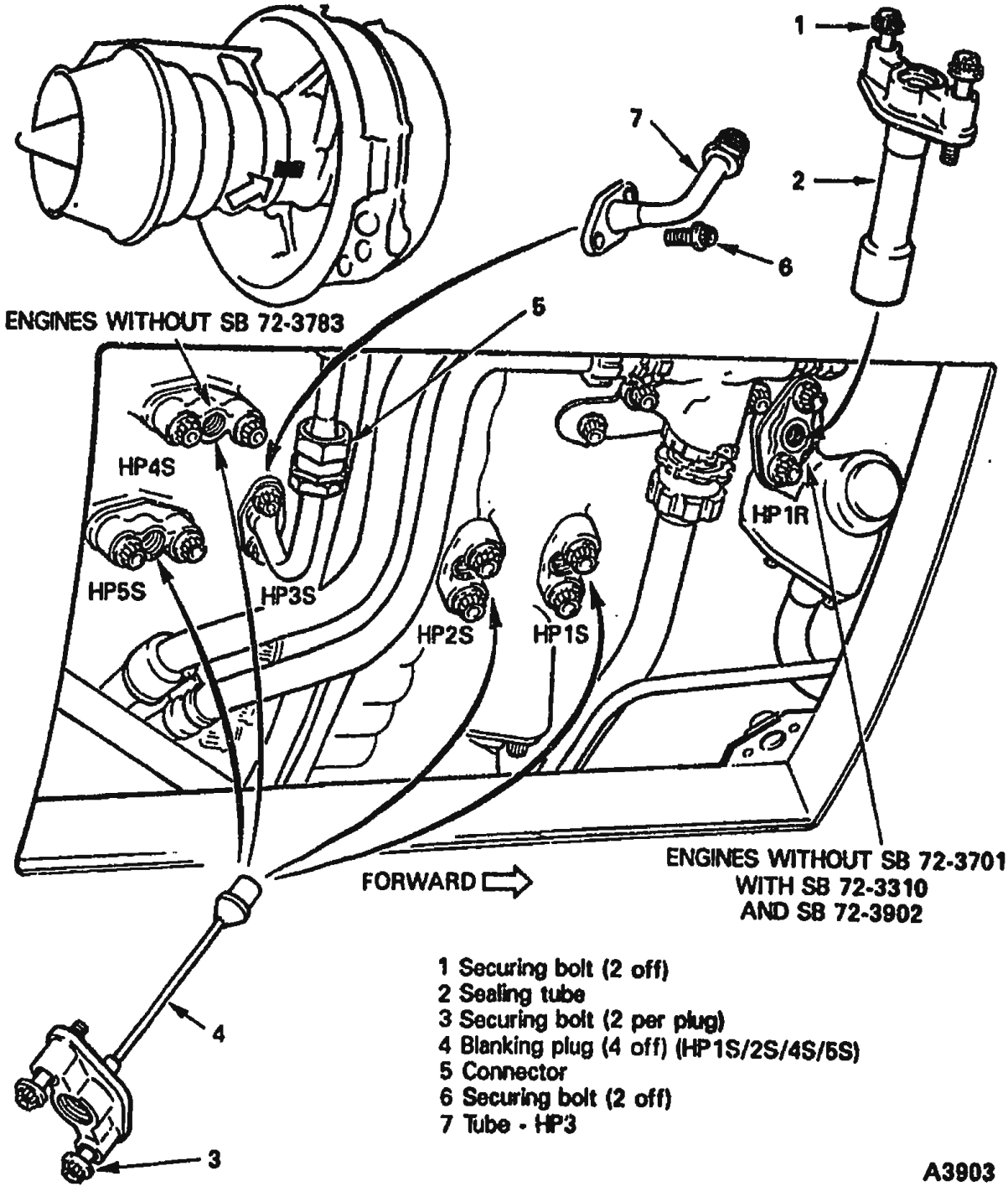
(4) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION. AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Cold liquid degrease end of sealing tube (2) and mating faces of sealing tube and compressor case; allow to dry.

(5) R Brush apply a thin coat of dry film lubricant to
R location surface of tube end and jointing compound to
R the mating faces of sealing tube and compressor case.

(6) CAUTION: ENSURE SEALING TUBE IS CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
While lubricant is still wet, position sealing tube in compressor case and secure (Ref.70-51-00) with bolts (1).

K. Inspect Stage 1 and 2 H.P. Compressor Blades

(1) Refer to fig.605, at H.P.1S position remove bolts (3) and using impact extractor, remove blanking plug (4).




R H.P. compressor borescope access
R Fig.605

(2) Carefully insert probe with viewing aperture facing forward, rotate H.P. system (Ref. 72-00-00, Servicing) inspect rear surface of stage 1 H.P. compressor blades; turn probe through 180 degrees and inspect front surface of stage 2 H.P. compressor blades.

(3) Withdraw probe.

(4) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION. AVOID SKIN CONTACT AND INHALING THE VAPOUR
Cold liquid degrease end of blanking plug (4) and also mating faces of blanking plug and compressor case; allow to dry.

(5) Brush apply a thin coat of dry film lubricant to location surface of plug end and jointing compound to the mating faces of blanking plug and compressor case.

(6) CAUTION: ENSURE BLANKING PLUG IS CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
While lubricant is still wet, position blanking plug in compressor case and secure (Ref.70-51-00) with bolts (3).

L. Inspect Stage 2 and 3 H.P. Compressor Rotor Blades

(1) Repeat operation K.(1) at H.P.2S position.

(2) Carefully insert probe with viewing aperture facing forward, rotate H.P. system (Ref. 72-00-00, Servicing) and inspect rear surface of stage 2 H.P. compressor blades; turn probe through 180 degrees and inspect front surface of stage 3 H.P. compressor blades.

(3) Withdraw probe.

(4) Repeat operations K.(4), (5) and (6) at H.P.2S position.

M. Inspect Stage 3 and 4 H.P. Compressor Blades

(1) At H.P.3S position release connector (5), remove bolts (6) and remove tube (7).

(2) Carefully insert probe with viewing aperture facing forward, rotate H.P. system (Ref. 72-00-00, Servicing) and inspect rear surface of stage 3 H.P. compressor blades; turn probe through 180 degrees and inspect front surface of stage 4 H.P. compressor blades.

(3) Withdraw probe.

(4) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION. AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Cold liquid degrease mating faces of tube (7) and compressor case; allow to dry.

R (5) Brush apply a thin coat of jointing compound to mating faces of tube and compressor case.

(6) CAUTION: ENSURE TUBE IS CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
While lubricant is still wet, position tube on compressor case, fit and secure (Ref. 70-51-00), bolts (6) tighten connector (5) and wirelock.

N. Inspect Stage 4 and 5 H.P. Compressor Blades - engines without S.B.72-3783

(1) Repeat operation K.(1) at H.P.4S position.

(2) Carefully insert probe with viewing aperture facing forward, rotate H.P. system (Ref. 72-00-00, Servicing) and inspect rear surface of stage 4 H.P. compressor blades; turn probe through 180 degrees and inspect front surface of stage 5 H.P. compressor blades.

(3) Withdraw probe.

(4) Repeat operations K.(4), (5) and (6) at H.P.4S position.

P. Inspect Stage 5 and 6 H.P. Compressor Blades

(1) Repeat operation K.(1) at H.P.5S position.

(2) Carefully insert probe with viewing aperture facing forward, rotate H.P. system (Ref. 72-00-00, Servicing) and inspect rear surface of stage 5 H.P. compressor blades; turn probe through 180 degrees and inspect front surface of stage 6 H.P. compressor blades.

(3) Withdraw probe.

(4) Repeat operations K.(4), (5) and (6) at H.P.5S position.

Q. On completion of inspection, disassemble inspection equipment (Ref. para.2.A.) and remove H.P. system turning tool (Ref. 72-00-00, Servicing).

R. Fit and secure access panel in compressor section rear R.H. fairing (412FR, 422FR or 432FR).

S. Remove protective work mats from cold stream duct.

T. Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

6. Inspect Combustion Liner and H.P. Turbine Nozzle Guide Vanes

A. The following operations detail combustion liner and nozzle guide vane borescope inspection procedure. For specific component inspection and associated acceptance standards refer to 72-40-00, Inspection/Check and 72-53-00, Inspection/Check.

B. WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref. 78-30-00, Servicing).

C. Equipment required:

| | |
|---|---|
| 289200 or C 4G 4342 | Protective work mats |
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |
| R 1702209 or 1702275 or 1702377 | Endoprobe (NDT No.011/V90 deg./380/MAPV ch 30 deg.) |
| Small, clean brush | |

D. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | B.S.4487: 1969 | Mil-T-81533 | 1/21 |
| R Dry film lubricant | PL198 | - | 4/20 |
| Lockwire | DTD.189A 22 S.W.G. | - 21 A.W.G. | 238 |

E. Position working platform or protective work mats in cold stream duct.

NOTE: Working platform is required in cold stream duct for blanking plug positions 2, 4, 14 and 16; work mats are required in cold stream duct for blanking plug positions 6, 8, 10 and 12.

F. Remove combustion section L.H. (412JL, 422JL or 432JL), R.H. (412JR, 422JR or 432JR) and upper fairings (Ref. 72-03-00, Removal/Installation).

G. R Assemble inspection equipment (Ref. para.2.A.) using probe 1702209 or 1702275 or 1702377.

H. Remove blanking plugs rear of fuel spray nozzles (Ref. fig.606)

(1) The spray nozzles are numbered clockwise from rear, No.1 being to the right of top dead centre.

(2) Fuel spray nozzle positions 6, 8, 10, 12, 14 and 16.

(a) Remove bolts (1) and blanking plugs (2).

R (3) Fuel spray nozzle position 4.

R (a) Engines without S.B.72-2592 or S.B.75-2668.

R (i) Disconnect connector (3) then remove tube (4), bolts (5) and bracket assembly (6) to expose blanking plug (2).

R (ii) Remove blanking plug.

R (b) Engines with S.B.72-2592

R (i) Disconnect connector (3) then remove tube (4), bolts (5), bracket and blanking plug assembly (7).

R (c) Engines with S.B.75-2668

R (i) Repeat operation (2).

R (4) Fuel spray nozzle position 2.

R (a) Engines without A.I.D.S.

R (i) Repeat operation (2).

R (b) Engines with A.I.D.S.

R (i) CAUTION: AVOID KINKING OR BENDING THE SECTION OF MINERAL INSULATED (M.I.) CABLE INTEGRAL WITH THE THERMOCOUPLE.
Remove bolts (8) and thermocouple (9).

R J. Carefully insert probe in access port and inspect combustion chamber interior and H.P. turbine nozzle guide vanes; withdraw probe. Repeat this procedure at each of the remaining access ports.

R K. Fit blanking plugs rear of fuel spray nozzles (Ref.fig.606).

R (1) The spray nozzles are numbered clockwise from rear, No.1 being to the right of top dead centre.

R (2) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION. AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Cold liquid degrease mating faces of blanking plugs, combustion outer case and on engines with A.I.D.S., thermocouple; allow to dry.

R (3) Fuel spray nozzle position 6, 8, 10, 12, 14 and 16.

NOTE: If H.P. turbine blades are also being inspected on engines without S.B.72-2588 do not fit the blanking plug at spray nozzle position 8.

(a) Brush apply a thin coat of dry film lubricant to mating faces of blanking plugs (2) and combustion outer case.

(b) CAUTION: ENSURE BLANKING PLUGS ARE CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
While lubricant is still wet, position blanking plugs in combustion outer case and secure (Ref.70-51-00) with bolts (1).

R (4) Fuel spray nozzle position 4.

(a) Engines without S.B.72-2592 or S.B.75-2668.

(i) Brush apply a thin coat of dry film lubricant to mating faces of blanking plug (2) and combustion outer case.

(ii) CAUTION: ENSURE BLANKING PLUG IS CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
While lubricant is still wet, position blanking plug in combustion outer case then position bracket assembly on blanking plug and secure (Ref.70-51-00) with bolts (5).

(iii) CAUTION: ENSURE P4 AIR TUBE AND CONNECTORS ARE CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
Fit tube (4), connect connector (3) then tighten (Ref.70-51-00) connectors and wirelock.

R (b) Engines with S.B.72-2592.

R (i) Brush apply a thin coat of dry film lubricant
R to mating faces of bracket and blanking plug
R assembly (7) and combustion outer case.

R (ii) CAUTION: ENSURE BLANKING PLUG IS CORRECTLY
R FITTED AND SECURED AFTER BORESCOPE
R INSPECTION. FAILURE TO DO SO CAN
R RESULT IN ENGINE DAMAGE.
R While lubricant is still wet, position bracket
R and blanking plug assembly in combustion outer
R case and secure (Ref.70-51-00) with bolts (5).

R (iii) CAUTION: ENSURE P4 AIR TUBE AND CONNECTORS ARE
R CORRECTLY FITTED AND SECURED AFTER
R BORESCOPE INSPECTION. FAILURE TO DO
R SO CAN RESULT IN ENGINE DAMAGE.
R Fit tube (4), connect connector (3) then
R tighten (Ref.70-51-00) connectors and wirelock.

R (c) Engines with S.B.75-2668

R (i) Repeat operation (3).

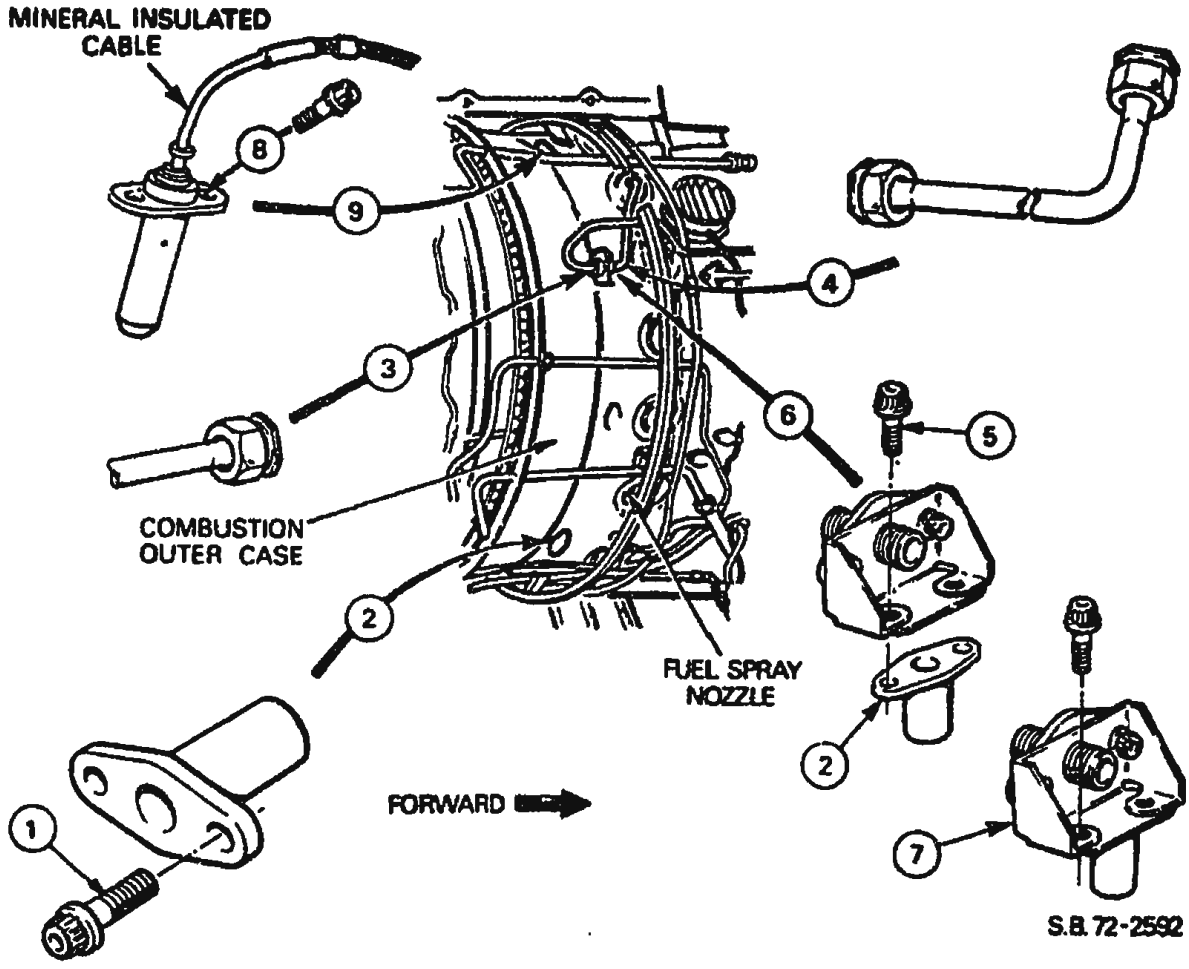
R (5) Fuel spray nozzle position 2.

R (a) Engines without A.I.D.S.

R (i) Repeat operation (2).

R (b) Engines with A.I.D.S.

R (i) Brush apply a thin coat of dry film lubricant
R mating faces of thermocouple (9) and combustion
R outer case.




1. Securing bolt (2 per plug)
2. Blanking plug (pre S.B. 72-2592, 7 off - 72-40-03, 01-080 and 01-050)
   (S.B.72-2592, 6 off - 72-40-03, 01-080)
   (S.B.75-2668, 7 off - 72-40-03, 01-080 and 01-050)
3. Connector - P4 air tube to union
4. Tube - P4 air, union to spray nozzle
5. Securing bolt (2 off)
6. Bracket assembly
7. Bracket and blanking plug assembly (72-40-03, 01-040)
8. Securing bolts (2 off)
9. Thermocouple

30707A

Combustion liner and nozzle guide vane borescope access
Fig.606

R (ii) CAUTION: 1. AVOID KINKING OR BENDING THE
R SECTION OF MINERAL INSULATED
R (M.I.) CABLE INTEGRAL WITH THE
R THERMOCOUPLE.

R 2. ENSURE THERMOCOUPLE IS CORRECTLY
R FITTED AND SECURED AFTER
R BORESCOPE INSPECTION. FAILURE TO
R DO SO CAN RESULT IN ENGINE
R DAMAGE.
R While lubricant is still wet, position
R thermocouple in combustion outer case ensuring
R positive location of baulking pin, and secure
R (Ref.70-51-00) with bolts (8).

R L. On completion of inspection, disassemble inspection equipment (Ref. para.2.A.).

R M. Fit combustion section L.H. (412JL, 422JL or 432JL), R.H. (412JR, 422JR or 432JR) and upper fairings (Ref. 72-03-00, Removal/Installation).

R N. Remove working platform or protective work mats from cold stream duct.

R P. Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

7. Inspect H.P. Turbine Blades and I.P. Turbine Blade Front Surface

A. The following operations detail two H.P. turbine blade borescope inspection procedures (engines incorporating S.B.72-2379 and engines incorporating S.B.72-2588) and an I.P. turbine blade borescope inspection procedure. For specific component inspection and associated acceptance standards refer to 72-52-00, Inspection/Check and 72-53-00, Inspection/Check.

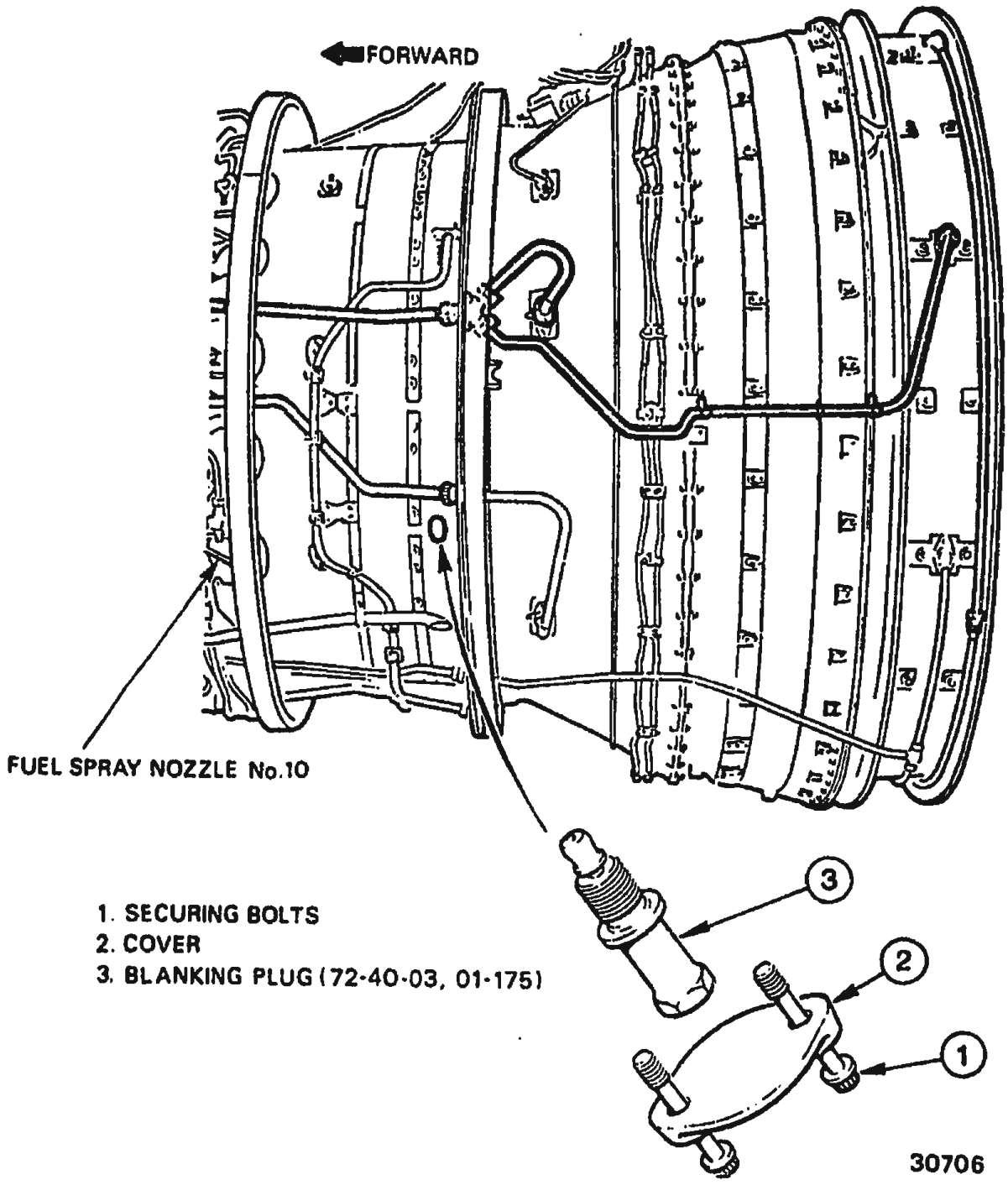
C NOTE: For AVM problems, it is only necessary to inspect
C trailing edge of turbine blades (See 7.K.).

B. WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref. 78-30-00, Servicing).

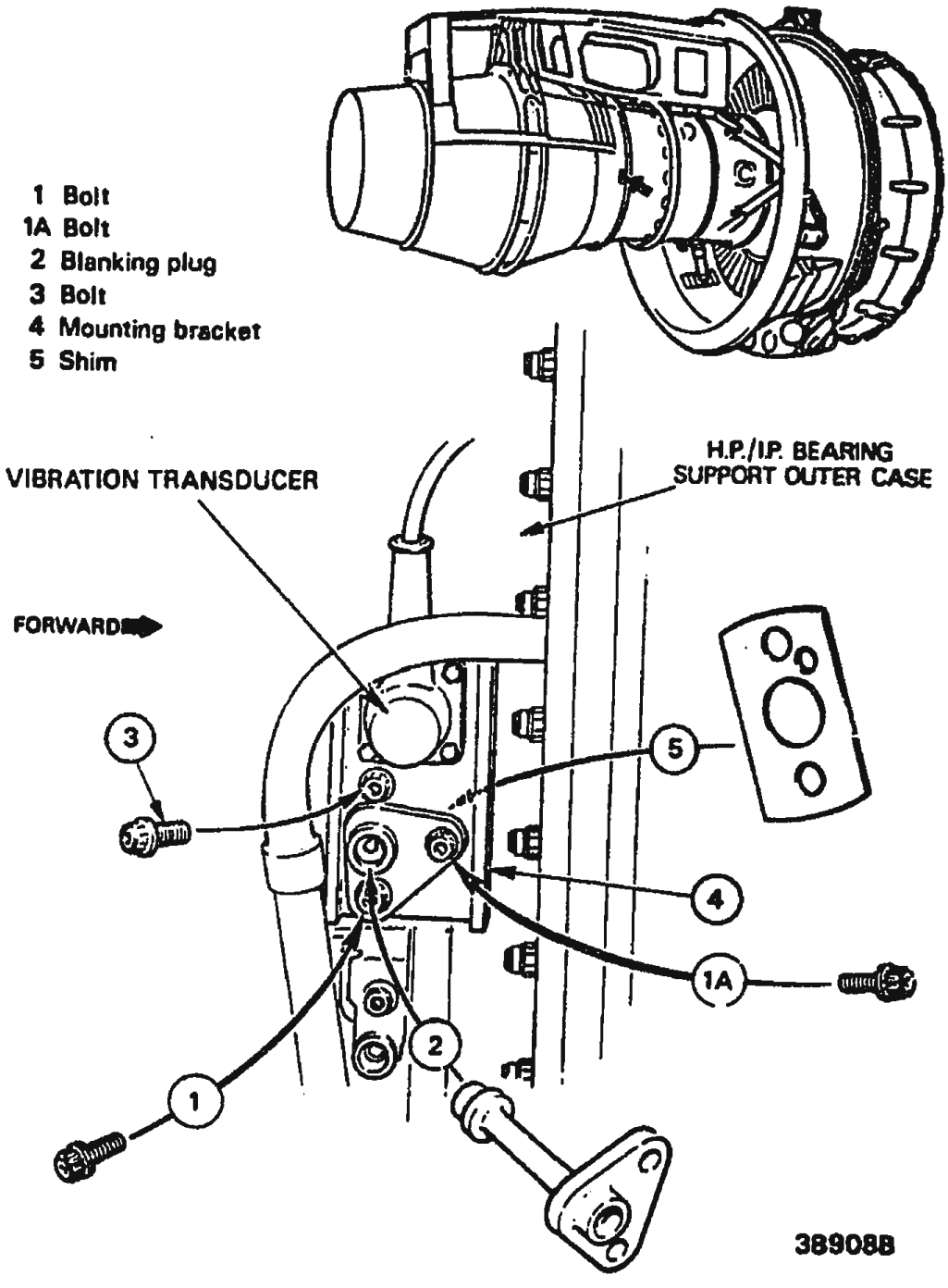
C. Equipment required:

| | | |
|---|---|---|
| | 289200 or C 4G 4342 | Protective work mats |
| * | UT.1019 | Guide tube |
| | HU.19036 | Impact extractor |
| R | 1702209 or 1702275 or 1702377 | Endoprobe (NDT No./011/V90 deg./380/ MAPV ch 30 deg.) |
| | 1702193 | Endoprobe (NDT No.Ø8/V90 deg./325) |
| R | or | |
| R | 1702374 | Endoprobe |
| | 1702226 | Endoprobe (NDT No.Ø8/V60 deg./325) |
| R | or | |
| R | 1702375 | Endoprobe |
| * | 1702243 | Flexible borescope (ACMI No.BFOF3127DD) |
| | Small, clean brush | |

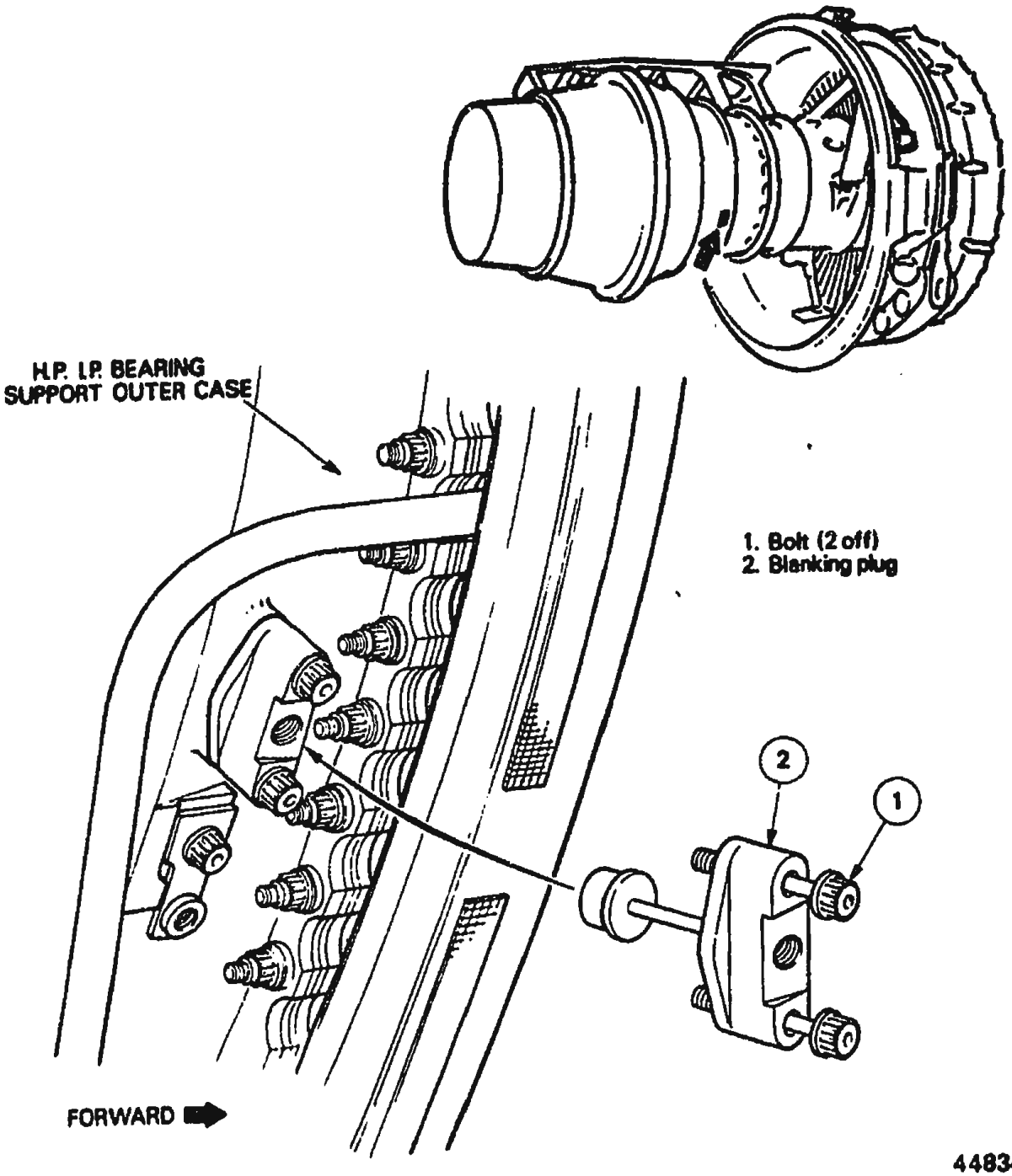
* Items not required on engines incorporating S.B.72-2588




H.P. turbine borescope access
Fig.607




H.P./I.P. turbine borescope access
(Engines without S.B.72-4834, S.B.77-4644, S.B.77-5387)
Fig.608 (Sheet 1)




H.P./I.P. turbine borescope access
(Engines with S.B.72-4834, S.B.77-4644, S.B.77-5387)
Fig.608 (Sheet 2)

D. Material required:

| | | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|---|
| | Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | B.S.4487: 1969 | Mil-T-81533 | 1/21 |
| R | Dry film lubricant | PL198 | - | 4/20 |

E. Remove combustion section R.H. fairing (412JR, 422JR or 432JR) and turbine section lower fairing (417A, 427A or 437A) (Ref. 72-03-00, Removal/Installation).

F. Position work mats in cold stream duct.

G. Fit H.P. and I.P. system turning tools (Ref. 72-00-00, Servicing).

H. Assemble inspection equipment (Ref. para.2.A. and B.)
R using 1702209 or 1702275 or 1702193 or 1702377 or 1702374 and,
R if required, probe 1702226 or 1702375 for blade root inspection, and flexible borescope.

J. Inspect H.P. Turbine Blade Front Surface - Engines incorporating S.B.72-2379

(1) Refer to fig.606, remove blanking plug rear of fuel spray nozzle position 8.

NOTE: The spray nozzles are numbered clockwise viewed from rear, No.1 being to right of top dead centre.

(a) Remove bolts (1) and blanking plug (2).

(2) Insert guide tube in access port ensuring tube extends rearwards, and secure using bolts (1).

(3) CAUTION: ENSURE FLEXIBLE BORESCOPE VIEWING TIP DOES NOT PROTRUDE BEYOND TRAILING EDGE OF H.P. TURBINE NOZZLE GUIDE VANES.
Carefully insert flexible borescope through guide tube; rotate H.P. system (Ref. 72-00-00, Servicing) and inspect front surface of H.P. turbine blades.

(4) Withdraw flexible borescope and remove guide tube.

(5) Fit blanking plug rear of fuel spray nozzle position 8.

(a) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION. AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Cold liquid degrease mating faces of blanking plug (2) and combustion outer case; allow to dry.

(b) Brush apply a thin coat of dry film lubricant to mating faces of blanking plug and combustion outer case.

(c) CAUTION: ENSURE BLANKING PLUG IS CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
While lubricant is still wet, position blanking plug in combustion outer case and secure (Ref.70-51-00) with bolts (1).

K. Inspect H.P. Turbine Blade Front Surface - Engines incorporating S.B.72-2588

(1) Refer to fig.607, remove bolts (1), cover (2). and blanking plug (3).

R (2) Carefully insert probe 1702193 or 1702374 (or probe
R 1702226 or 1702375 for blade root inspection) with viewing aperture facing rearward; rotate H.P. system (Ref.72-00-00, Servicing) and inspect front surface of H.P. turbine blades.

(3) Withdraw probe.

(4) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION. AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Cold liquid degrease threads of blanking plug (3) and mating faces of cover (2) and combustion outer case; allow to dry.

(5) Brush apply a thin coat of dry film lubricant to threads of blanking plug.

(6) While lubricant is still wet fit blanking plug
C and torque tighten to 200 lb.in.

(7) CAUTION: ENSURE COVER IS CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
Brush apply a thin coat of dry film lubricant to mating faces of cover and combustion outer case; while lubricant is still wet position cover on combustion outer case and secure (Ref.70-51-00) with bolts (1).

L. Inspect H.P. Turbine Blade Surfaces from the Rear and I.P. Turbine Blade Surfaces from the Front

(1) Inspect H.P. turbine blade convex surface using NDT inspection equipment.

(a) Engines without S.B.72-4834, S.B.77-4644 or S.B.77-5387 refer to fig.608 (Sheet 1).

(i) Remove turbine case transducer (Ref.77-31-01).

(ii) Remove bolts (1) and (1A) and using impact extractor, remove blanking plug (2).

(iii) Remove bolt (3) and carefully remove mounting bracket (4) and shim (5).

(b) Engines with S.B.72-4834, S.B.77-4644 or S.B.77-5387 refer to fig.608 (Sheet 2).

(i) Remove bolts (1) and using impact extractor remove blanking plug (2).

R (c) Carefully insert probe 1702209 or 1702275 or 1702377
R (or probe 1702226 or 1702375 for blade root inspection) with viewing aperture facing forward; rotate H.P. system (Ref. 72-00-00, Servicing) and inspect convex surface of H.P. turbine blades.

(d) Inspect blade shrouds, shroud interlocks and tip seal fins.

(e) Withdraw probe

R (f) Engines without S.B.72-4834, S.B.77-4644 or
R S.B.77-5387 refer to fig.608 (Sheet 1)

R (i) WARNING: WHEN USING DEGREASING FLUID ENSURE
R ADEQUATE VENTILATION. AVOID SKIN
R CONTACT AND INHALING THE VAPOUR.
R Cold liquid degrease end of blanking plug (2),
R mating faces of blanking plug and turbine
R outer case, and also to both surface of
R mounting bracket (4) and shim (5); allow
R to dry.

R (ii) Brush apply a thin coat of dry film lubricant
R to location surface of plug end, mating faces
R of blanking plug and turbine outer case and
R also to both surfaces of mounting bracket and
R shim.

R (iii) While lubricant is still wet, position shim
R and mounting bracket on turbine outer case
R and fit bolt (3), do not tighten at this stage.

R NOTE: On engines without S.B.72-5276, bolt (3)
R is shorter in length than bolts (1) and
R (1A). On engines with S.B.72-5276, all
R bolts are the same length.

R (iv) CAUTION: ENSURE BORESCOPE BLANKING PLUG IS
R CORRECTLY FITTED AND SECURED AFTER
R BORESCOPE INSPECTION. FAILURE TO
R. DO SO CAN RESULT IN ENGINE DAMAGE.
R Position blanking plug in turbine outer case and
R secure (Ref. 70-51-00) with bolts (1) and (1A).

R (v) Secure (Ref.70-51-00) bolt (3).

R (vi) Install I.P. turbine case transducer
R (Ref.77-31-00).

R (g) Engines with S.B.72-48354, S.B.77-4644 or
R S.B.5387 refer to fig.608 (Sheet 2).

R (i) WARNING: WHEN USING DEGREASING FLUID, ENSURE
R ADEQUATE VENTILATION. AVOID SKIN
R CONTACT AND INHALING THE VAPOUR.
R Cold liquid degrease end of blanking plug (2)
R and also mating faces of blanking plug and
R turbine outer case; allow to dry.

R (ii) Brush apply a thin coat of dry film lubricant
R to location surface of plug end and also to
R mating faces of blanking plug and turbine
R outer case.

R (iii) CAUTION: ENSURE BLANKING PLUG IS CORRECTLY
R FITTED AND SECURED AFTER BORESCOPE
R INSPECTION. FAILURE TO DO SO CAN
R RESULT IN ENGINE DAMAGE.
R While lubricant is still wet, position
R blanking plug in turbine outer case and
R secure with bolts (1).

R (h) On completion of inspection, disassemble inspection equipment (Ref. para.2.A. and B.) and remove H.P. system turning tools (Ref. 72-00-00, Servicing).

(2) Inspect H.P. turbine blade concave surface using Olympus inspection equipment.

CAUTION: THE FIBERSCOPE MUST BE HANDLED WITH CARE AND TIGHT BENDS AVOIDED AS DAMAGE TO THE INDIVIDUAL FIBRES WILL RESULT.

(a) Equipment required:

| | |
|---|---|
| 1702319 | Fiberscope (Olympus No.IF6D2-10) |
| 1702320 | Light source box (KeyMed No.KLS2) |
| 1702321 | Stop adapter |
| UT1197 | Guide tube |

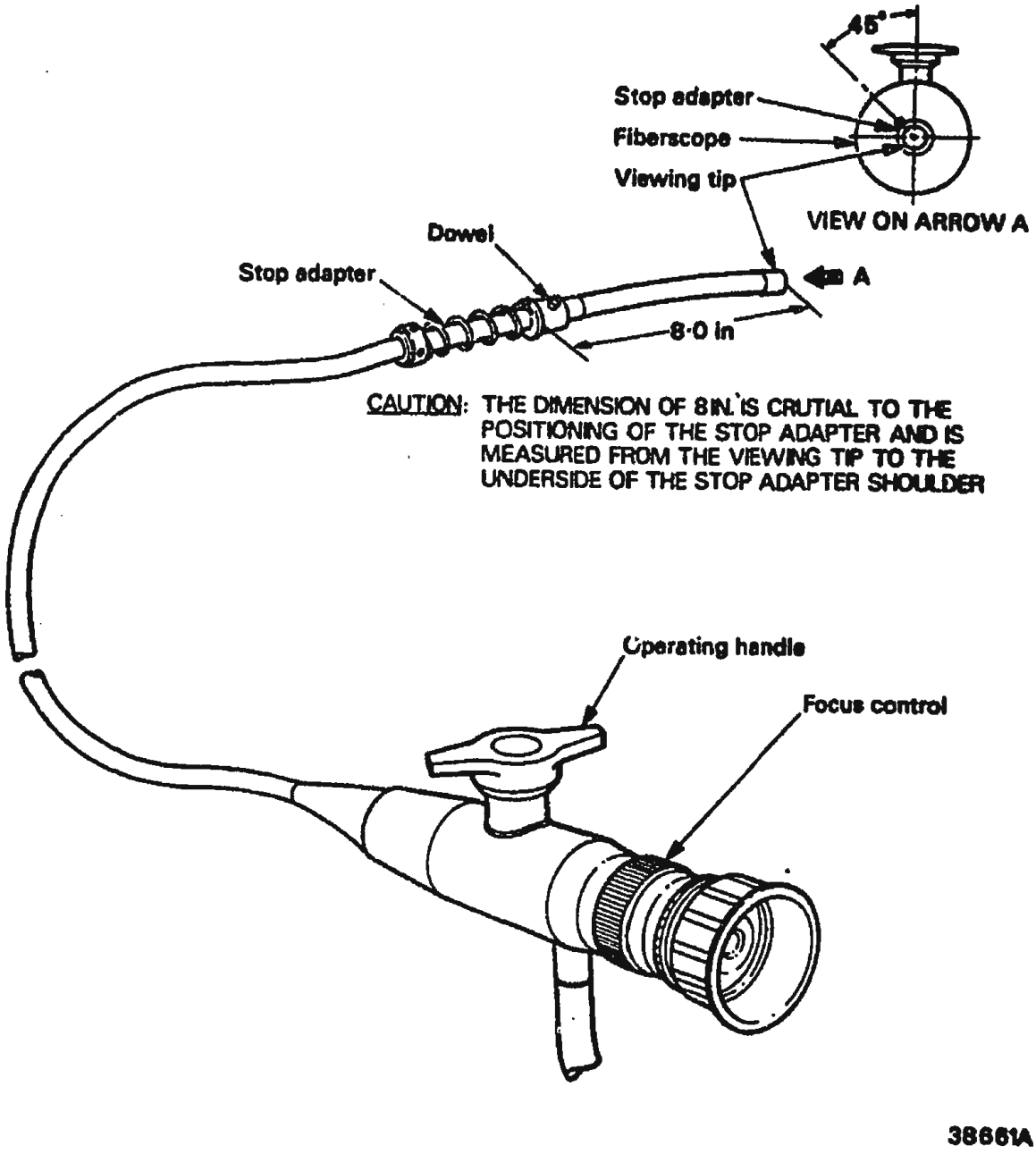
(b) Ensure voltage selector switch at rear of light source box is selected to correct supply voltage.

(c) Connect fiberscope to light outlet (position 1 or 2 as required), turn intensity control (adjacent to applicable light outlet) to zero and select LAMP l or LAMP 2 switch to appropriate position.

(d) Position stop adapter over tip end of fiberscope, ensuring dowel pin end of stop adapter is nearest to viewing tip end of fiberscope

(e) CAUTION: IT IS ESSENTIAL THAT THE FOLLOWING PROCEDURE IS ADHERED TO. FAILURE TO DO SO WILL RESULT IN THE FIBERSCOPE VIEWING TIP BEING PLACED IN THE ROTATIONAL PATH OF THE H.P. TURBINE BLADES.

Refer to fig.609, with fiberscope in horizontal position and with fiberscope operating handle uppermost, slide stop adapter along fiberscope
R until it is 8.0in. (203,2 mm.) from tip of fiberscope (measurement is from underside of flange immediately above dowel pin, to viewing tip of scope). Ensuring this measurement is maintained, position dowel at 45 degrees to left of operating handle vertical centre-line as viewed from viewing tip (Ref. fig.609) and lock in this position, using 4 screws situated in top collar of stop adapter.




Positioning of stop adapter on fiberscope
Fig.609

R (f) Repeat operation (1) (a) or (b) as applicable.

R (g) On engines without S.B.72-4834, S.B.77-4644 or
R S.B.77-5387, insert guide tube UT1197, ensuring it faces forward and that securing flange is vertical, and secure using bolt (3) at upper
R position and bolt (1) at lower position.

R (h) On engines with S.B.72-4834, S.B.77-4644 or
R S.B.77-5387, insert guide tube UT1197, ensuring it faces forward and securing flange is vertical.
R Secure using bolts (1).

R (j) On light source box, select POWER switch on and turn applicable intensity control to achieve optimum illumination.

R (k) CAUTION: DO NOT EXERT PRESSURE ON THE FIBERSCOPE AS THIS WILL COMPRESS THE SPRING ON THE STOP ADAPTER RESULTING IN THE VIEWING TIP OF THE FIBERSCOPE BEING POSITIONED IN THE ROTATIONAL PATH OF THE H.P. TURBINE BLADES.

Ensuring fiberscope operating handle is in neutral position (operating handle lugs at right-angles to fiberscope body), carefully insert fiberscope in guide tube until dowel pin of stop adapter is located in slot in guide tube, then focus fiberscope; slowly rotate H.P. system (Ref. 72-00-00, Servicing) and inspect mid-height positions of concave surface and trailing edge of each H.P. turbine blade.

R (l) If any blade is suspected of being cracked or damaged, proceed with operation (r).

R (m) Inspect blade shrouds, shroud interlocks and
R tip seal fins.

R (n) Turn fiberscope operating handle until blade root area is visible, then slowly rotate H.P. system (Ref. 72-00-00, Servicing) and inspect root areas of concave surfaces and trailing edge of each H.P. turbine blade.

R R (p) If any blade is suspected of being cracked or damaged, proceed with operation (r).

R R (q) Inspect blade shrouds, shroud interlocks and tip seal fins.

R (r) CAUTION: WHEN MAKING A CLOSE-UP INSPECTION OF A SPECIFIC AREA OF A BLADE, IT IS ESSENTIAL THAT THE H.P. SYSTEM IS NOT ROTATED, AS THE VIEWING TIP OF THE FIBERSCOPE WILL BE IN THE ROTATIONAL PATH OF THE H.P. TURBINE.
Gently push on fiberscope until spring on stop adapter is compressed, then turn operating handle until required area is visible. When inspection of area accomplished, release pressure on fiberscope until spring on stop adapter is fully extended before proceeding to next blade.

R (s) CAUTION: ENSURE OPERATING HANDLE IS IN THE NEUTRAL POSITION AS THE VIEWING TIP WILL BE DAMAGED WHEN BEING REMOVED FROM THE GUIDE TUBE IF IN AN OFFSET POSITION.
Carefully withdraw fiberscope from guide tube.

R (t) CAUTION: DO NOT REMOVE STOP ADAPTER FROM THE FIBERSCOPE AFTER USE AS CONSTANT REMOVAL AND FITMENT OF THE STOP ADAPTER TO THE FIBRESCOPE WILL DAMAGE THE FIBRES.
Select POWER switch on light source box to off position and disconnect fiberscope.

R (u) Remove bolts and withdraw guide tube.

R (v) Repeat operation (1) (f) or (g) as applicable.

R (w) Remove H.P. system turning tools (Ref. 72-00-00, Servicing).

(3) Inspect H.P. turbine blade concave surface using N.D.T. inspection equipment.

(a) Equipment required:

| | |
|---|---|
| 1702368 | Location stop (NDT No.A3/101/E) |
| 1702367 | Endoprobe (NDT No.011/V90 deg./238/MAPv-150 ch 10) |
| or | |
| 1702378 | Endoprobe |

(b) Repeat operation (1) (a) or (b) as applicable.

(c) On engines without S.B.72-4834, S.B.77-4644 or S.B.77-5387, fit probe support, location stop, securing with bolts (1) and (3).

(d) On engines with S.B.72-4834, S.B.77-4644 or S.B.77-5387, fit probe support, location stop, securing with bolts (1).

(e) Carefully insert probe with viewing aperture facing forward, rotate H.P. system (Ref. 72-00-00, Servicing) and inspect the concave side of the blades. To obtain the correct viewing position locate the probe in line with the centre line of the engine, viewing forward.

NOTE: To enable the inspection of the blades to be carried out in the detail required, it is essential that the rotation of the engine is controlled by the operator inspecting the blades by use of the automatic turning tool.

(f) Inspect blade shrouds, shroud interlocks and tip seal fins.

(g) Remove bolts and withdraw probe support location stop.

(h) Repeat operation (1) (f) or (g) as applicable.

(4) Inspect I.P. turbine blade front surface

(a) Repeat operation (1) (a) or (b) as applicable.

R
R (b) Carefully insert probe 1702209 or 1702275 or 1702377 (or probe 1702226 1702375 for blade root inspection) with viewing aperture facing rearward; rotate I.P. system (Ref. 72-00-00, Servicing) and inspect front surface of I.P. turbine blades.

(c) Withdraw probe.

(d) Repeat operation (1) (f) or (g) as applicable.

(e) On completion of inspection, disassemble inspection equipment (Ref. para.2.A. or B.) and remove I.P. system turning tools (Ref. 72-00-00, Servicing).

M. Remove protective work mats from cold stream duct.

N. Fit combustion section R.H. fairing (412JR, 422JR or 432JR) and turbine section lower fairing (417A, 427A or 437A) (Ref. 72-03-00, Removal/Installation).

P. Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

Q. Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

8. Inspect I.P. Turbine Blade Rear Surface and L.P. Turbine Blades

A. The following operations detail L.P. and I.P. turbine blade borescope inspection procedures. For specific component inspection and associated acceptance standards refer to 72-51-00, Inspection/Check, and 72-52-00, Inspection/Check.

B. WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref. 78-30-00, Servicing).

C. Equipment required:

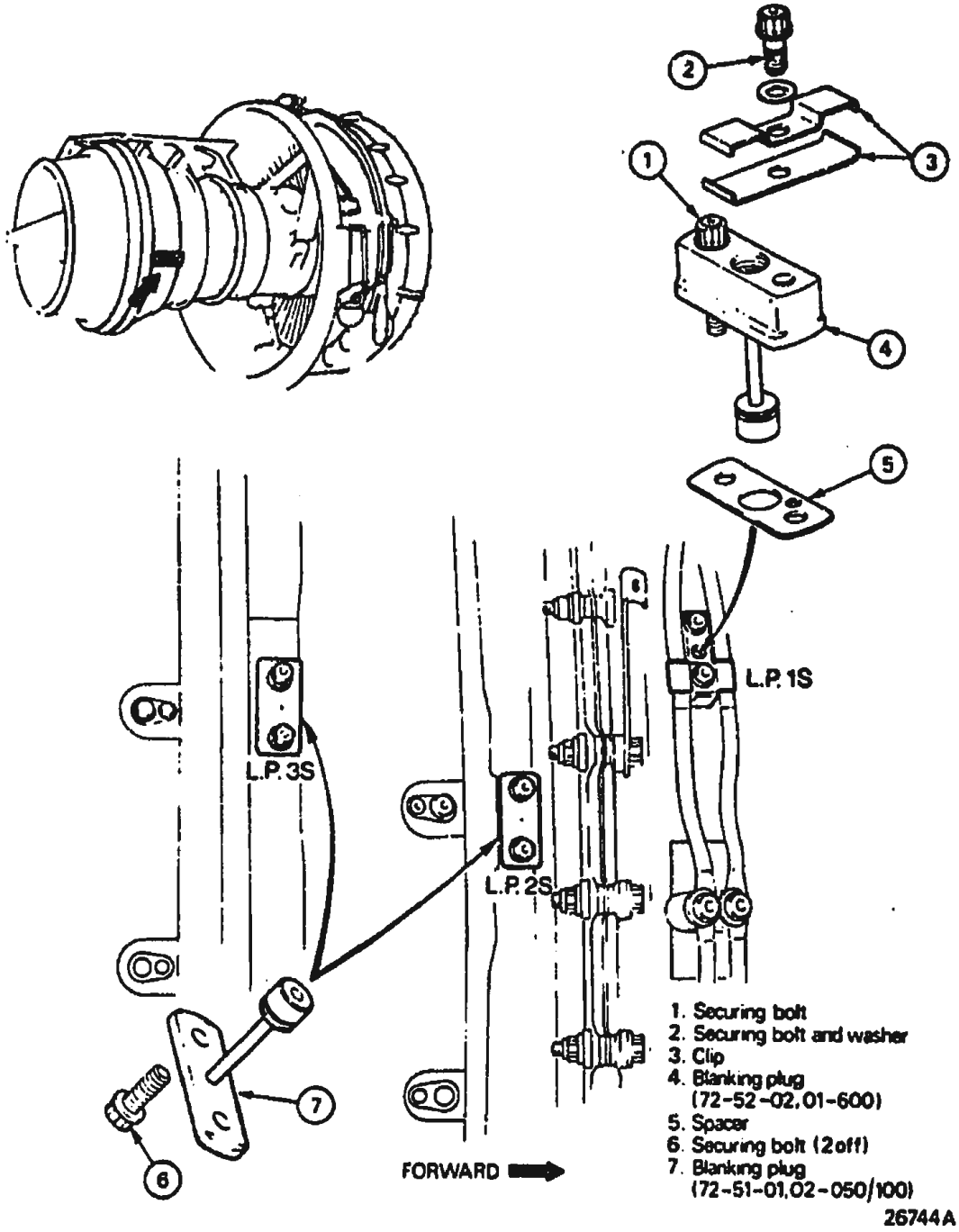
| | | |
|---|---|---|
| | 289200 or C 4G 4342 | Protective work mats |
| | HU.19036 | Impact extractor |
| | 1702193 | Endoprobe (NDT No.08/V90 deg./325) |
| R | or | |
| R | 1702374 | Endoprobe |
| | 1702226 | Endoprobe (NDT No./08/V60 deg./325) |
| R | or | |
| R | 1702375 | Endoprobe |
| | 1702197 | Right-angled viewer (NDT No.Z/RA) |
| | Small, clean bush | |

D. Material required:

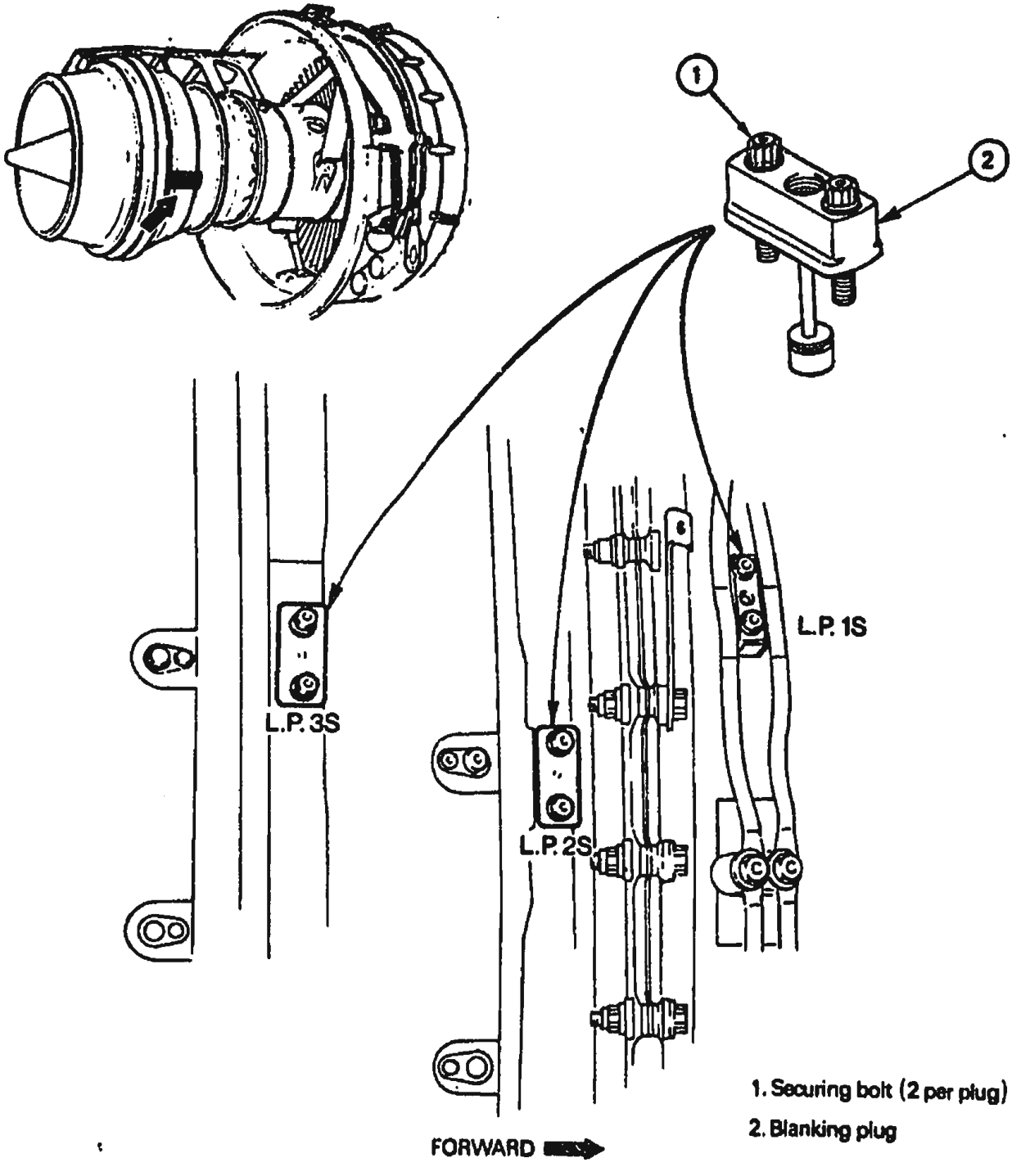
| | | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|---|
| | Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | B.S.4487: 1969 | Mil-T-81533 | 1/21 |
| R | Dry film lubricant | PL198 | - | 4/20 |

E. Remove turbine section lower fairing (417A, 427A or 437A) (Ref. 72-03-00, Removal/Installation).

F. Position protective work mats in cold stream duct.




I.P./L.P. turbine borescope access
Fig.610 (Sheet 1)




I.P./L.P. turbine borescope access
(S.B.78-3551)
Fig.610 (Sheet 2)

G. Fit I.P. system turning tool (Ref. 72-00-00, Servicing).

H. Assemble inspection equipment (Ref. para.2.A.) using
R probe 1702193 or 1702374, right-angled viewer and if required,
R probe 1702226 or 1702375 for blade root inspection.

J. Inspect I.P. Turbine Blade Rear Surfaces and Stage 1 L.P. Turbine Blades.

(1) Engines without S.B.78-3551 refer to fig.610 (Sheet 1).

(a) At L.P.1S position remove bolt (1), bolt and washer (2) and clip (3) then using impact extractor, remove blanking plug (4); on engines with S.B.72-2086, remove spacer (5).

(2) Engines with S.B.78-3551 refer to fig.610 (Sheet 2).

(a) At L.P.1S position remove bolts (1) and using impact extractor, remove blanking plug (2).

(3) Carefully insert probe with viewing aperture facing forward, rotate I.P. system (Ref. 72-00-00, Servicing) and inspect rear surface of I.P. turbine blades; turn probe through 180 degrees, rotate L.P. system (Ref. 72-00-00, Servicing) and inspect front surface of stage 1 L.P. turbine blades.

(4) Withdraw probe.

(5) Engines without S.B.78-3551 refer to fig.610 (Sheet 1).

(a) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION. AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Cold liquid degrease end of blanking plug (4), mating faces of blanking plug and turbine case; on engines with S.B.72-2086 both sides of spacer (5); allow to dry.

(b) Brush apply a thin coat of dry film lubricant to location surface of plug end, mating faces of blanking plug and turbine case, and on engines with S.B.72-2086, to both surfaces of spacer.

R (c) CAUTION: ENSURE BLANKING PLUG IS CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN CAN RESULT IN ENGINE DAMAGE.
While lubricant is still wet, on engines with S.B.72-2086, position spacer on turbine case, enter blanking plug in case ensuring positive location of dowel, position clip (3) on blanking plug then fit and secure (Ref. 70-51-00) bolt and washer (2) and bolt (1).

R NOTE: Ensure thermocouple harness is correctly located in clip.

R (6) Engines with S.B.78-3551 refer to fig.610 (Sheet 2).

R (a) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION. AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Cold liquid degrease end of blanking plug (2), and mating faces of blanking plug and turbine case; allow to dry.

R (b) Brush apply a thin coat of dry film lubricant to location surface of plug end and also to mating faces of blanking plug and turbine case.

R (c) CAUTION: ENSURE BLANKING PLUG IS CORRECTLY FITTED AND SECURED AFTER BORESCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
While lubricant is still wet, position blanking plug in turbine case and secure (Ref.70-51-00) with bolts (1).

R J. Inspect Stage 1 and 2 L.P. Turbine Blades

R (1) Engines without S.B.78-3551 refer to fig.610 (Sheet 1).

R (a) At L.P.2S position remove bolts (6) and blanking plug (7).

R (2) Engines with S.B.78-3551 refer to fig.610 (Sheet 2).

R (a) At L.P.2S position remove bolts (1) and blanking plug (2).

R (3) Carefully insert probe with viewing aperture facing forward, rotate L.P. system (Ref. 72-00-00, Servicing) R and inspect rear surface of stage 1 L.P. turbine blades; turn probe through 180 degrees, rotate L.P. system and R and inspect front surface of stage 2 L.P. turbine blades.

R (4) Withdraw probe.

R (5) Engine without S.B.78-3551 refer to fig.610 (Sheet 1).

R (a) WARNING: WHEN USING DEGREASING FLUID, ENSURE R ADEQUATE VENTILATION. AVOID SKIN R CONTACT AND INHALING THE VAPOUR.
R Cold liquid degrease end of blanking plug (7) and R mating faces of blanking plug and turbine case; R allow to dry.

R (b) Brush apply a thin coat of dry film lubricant to R location surface of plug end and also to mating R faces of blanking plug and case.

R (c) CAUTION: ENSURE BLANKING PLUG IS CORRECTLY FITTED R AND SECURED AFTER BORESCOPE INSPECTION. R FAILURE TO DO SO CAN RESULT IN ENGINE R DAMAGE.
R While lubricant is still wet, position blanking plug R in turbine case and secure (Ref.70-51-00) with bolts R (7).

R (6) Engine with S.B.78-3551 refer to fig.610 (Sheet 2).

R (a) WARNING: WHEN USING DEGREASING FLUID, ENSURE R ADEQUATE VENTILATION. AVOID SKIN R CONTACT AND INHALING THE VAPOUR.
R Cold liquid degrease end of blanking plug (2) and R mating faces of blanking plug and turbine case; R allow to dry.

R (b) Brush apply a thin coat of dry film lubricant to R location surface of plug end and also to mating R faces of blanking plug and case.

R (c) CAUTION: ENSURE BLANKING PLUG IS CORRECTLY FITTED R AND SECURED AFTER BORESCOPE INSPECTION. R FAILURE TO DO SO CAN RESULT IN ENGINE R DAMAGE.
R While lubricant is still wet, position blanking plug R in turbine case and secure (Ref.70-51-00) with bolts R (1).

R K. Inspect Stage 2 and 3 L.P. Turbine Blades

R (1) Repeat operation J.(1) or (2) as applicable at L.P.3S
R position.

R (2) Carefully insert probe with viewing aperture facing
R forward, rotate L.P. system (Ref. 72-00-00, Servicing)
R and inspect rear surface of stage 2 L.P. turbine blades;
turn probe through 180 degrees, rotate L.P. system and
R inspect front surface of stage 3 L.P. turbine blades.

R (3) Withdraw probe.

R (4) Repeat operations J.(5) or (6) as applicable.

R L. On completion of inspection, disassemble inspection equipment (Ref. para.2.A.) and remove I.P. system turning tool (Ref. 72-00-00, Servicing).

R M. Remove protective work mats from cold stream duct.

R N. Fit turbine section lower fairing (417A, 427A or 437A) (Ref. 72-03-00, Removal/Installation).

R P. Inspect Stage 3 L.P. Turbine Blades Rear Surface.

(1) Gain access to exhaust unit and using inspection lamp, inspect rear surface of stage 3 L.P. turbine
R blades.

R Q. Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

9. Inspect Stage 2 and 3 L.P. Turbine Nozzle Guide Vanes

A. Gain access to exhaust unit and using inspection lamp, inspect stage 3 and as far as possible, stage 2 L.P. turbine nozzle guide vanes.

10. Lease Engine Receipt and Interchange Inspection

A. General

R (1) The following is the minimum inspection which is required to be carried out by the receiving lessee or by Rolls-Royce when lease engine is passed from one lessee to another either direct or via Rolls-Royce. The normal post installation checks and tests detailed in the appropriate section of the Aircraft Maintenance Manual must be complied with for final proof of the engine serviceability.

B. Documentation Check

R (1) From the service records of the engine and from the information generated by the previous lessee in accorance with Lease Engine Termination Inspection,
R paragraph 11, an assessment must be made to ascertain:

R (a) That the engine was performing satisfactorily at the time of its last removal.

R (b) Whether there has been any malfunction during its previous service operation, or any maintenance work has been effected, which should require further investigation or rework before a further period of operation in service.

R (c) That all mandatory inspections and Service Bulletins have been complied with.

R (d) That Group A parts have not exceeded the life limitations and that sufficient life remains for the next lease operation.

R (e) That the requirements for inhibiting and storage have been complied with.

C. Inspection

(1) Accessory and installation items

(a) Check that the engine conforms to the configuration as supplied. The configuration is defined in part
R 10 or 11 of the following checking list:

R (i) Checking list 1502 - RB211-22B

(2) Visual inspection

(a) Visually inspect the engine, as far as access permits, for any signs of damage.

(3) Freedom of rotation

(a) Check that the L.P., I.P. and H.P. spools are all free to rotate as detailed in 72-00-00, Servicing.

R (4) Borescope inspection

(a) If blade damage is evident or suspected, effect
R a full borescope inspection as required.

(5) Oil system inspection

(a) Check the fine scavenge filter, the pressure filter and the magnetic chip detectors for contamination as detailed in 72-01-00, Inspect/Check.

## 11. Engine Lease Termination Inspection

### A. General

R (1) At the termination of an engine lease period and prior to the engine being submitted at the next lessee or back to Rolls-Royce the following procedure should be effected by the current lessee. This procedure is the minimum necessary to ensure that the engine is in a satisfactory condition upon receipt by the new lessee or by Rolls-Royce. If the engine is not to be dispatched immediately upon completion of this procedure and is stored for a period of time, it will be necessary to effect the R procedure in paragraph L. immediately prior to final dispatch.

### B. Performance Test

(1) Effect a performance test (Test 7, 71-00-00, Adjustment/Test) to ascertain that the engine is performing satisfactorily. Refer also to NOTE (2) R in paragraph (K).

NOTE: If circumstances prevent the performance test from being effected, a copy of the "In flight Performance Monitioring Log" will be required to provide evidence of the performance status.

### C. Accessory and Installation Items

(1) Check that the engine conforms to the configuration as supplied. The configuration is defined in part 10 or R part 11 of the following checking list:

R (a) Checking List 1502 - RB211-22B

(2) Make up any deficiencies or agree a deficiency list with Rolls-Royce.

### D. Visual Inspection

(1) Visually inspect the engine, as far as access permits, for any signs of damage, corrosion and/or contamination.

E. Freedom of Rotation

(1) Check that the L.P., I.P. and H.P. spools are all free to rotate as detailed in 72-00-00, Servicing.

R F. Borescope Inspection

R (1) Effect a full borescope inspection as required.

G. Oil System Inspection

(1) Check the fine scavenge filter, the pressure filter and the magnetic chip detectors for contamination as detailed in 72-01-00, Inspection/Check.

H. Inhibit the Fuel System

(1) Inhibit the fuel system as detailed in 73-00-00, Servicing as required by Rolls-Royce.

R J. Preserve the Engine

R (1) Prepare the engine for Storage and Dispatch as detailed in 71-00-00, Preservation as required by Rolls-Royce.

R K. Documentation

(1) Prepare and submit a copy of the following documentation to Rolls-Royce or its nominee, the original documents being transported with the engine to its next destination.

(a) A list of all entries made against the engine in the Flight Log and Technical Log during the period of the lease and corrective actions taken.

(b) Engine log card.

(c) A list of Group A component serial numbers and flight cycles completed, if not entered on the engine log card.

(d) The results of a performance test or a copy of the "In-Flight Performance Monitoring Log", see paragraph B.

(e) A list of mandatory Service Bulletins and Inspections, carried out during the period of this lease, if not entered on the log card.

(f) Record any discrepancies found during the inspection procedure, particularly with respect to paragraphs C. D. E. F and G.

(g) Enter on the engine log card:

Engine Lease Termination Inspection Ref. Aircraft Maintenance Manual 72-00-00, page block 601, completed".

NOTE: (1) If the engine has been fully overhauled, it will be passed as serviceable in accordance with requirements for a fully overhauled item.

(2) If the engine has been tested on termination of the lease, paragraph B will be superseded, and a copy of the
R test results will supersede (d).

(3) An inspection signature is required for item (g).

R L. Dispatch Inspection

NOTE: This procedure is not necessary if the engine is to be dispatched immediately upon completion of
R procedures paragraphs A thru K.

(1) Open the M.V.P. bag to gain access to the engine.

(2) Check that the engine still conforms to the configuration as stored; reference paragraph C.

(3) Check the engine, as far as access permits, for any signs of damage.

(4) Effect the necessary preservation procedure as detailed in 71-00-00, Cleaning, Painting and Preservation.

R (5) Ensure that all documents referred to in paragraph K., actually accompany the engine on dispatch.

R H.P. SYSTEM MODULE - REMOVAL/INSTALLATION

R 1. Removal/Installation Gas Generator Fairing Support Brackets

R Referenced Procedures

R 72-03-00 Gas Generator Fairings - Removal/Installation
R 78-30-00 Thrust Reverser System - Servicing

R Illustrated Parts Catalogue References

R The I.P.C. sections where parts disturbed during the following
R operations can be located are as follows:

R 72-00-04 H.P. Module Installation

R A. Remove support brackets

R (1) Equipment required:

R 289200 or C 4G 4342 Protective work mats

R (2) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN
R FORWARD THRUST POSITION (REF. 78-30-00)
R WHILE WORK IS IN PRGGRESS.
R Deactivate and tag thrust reverser and associated
R systems, and fit thrust reverser mechanical locks
R (Ref. 78-30-00).

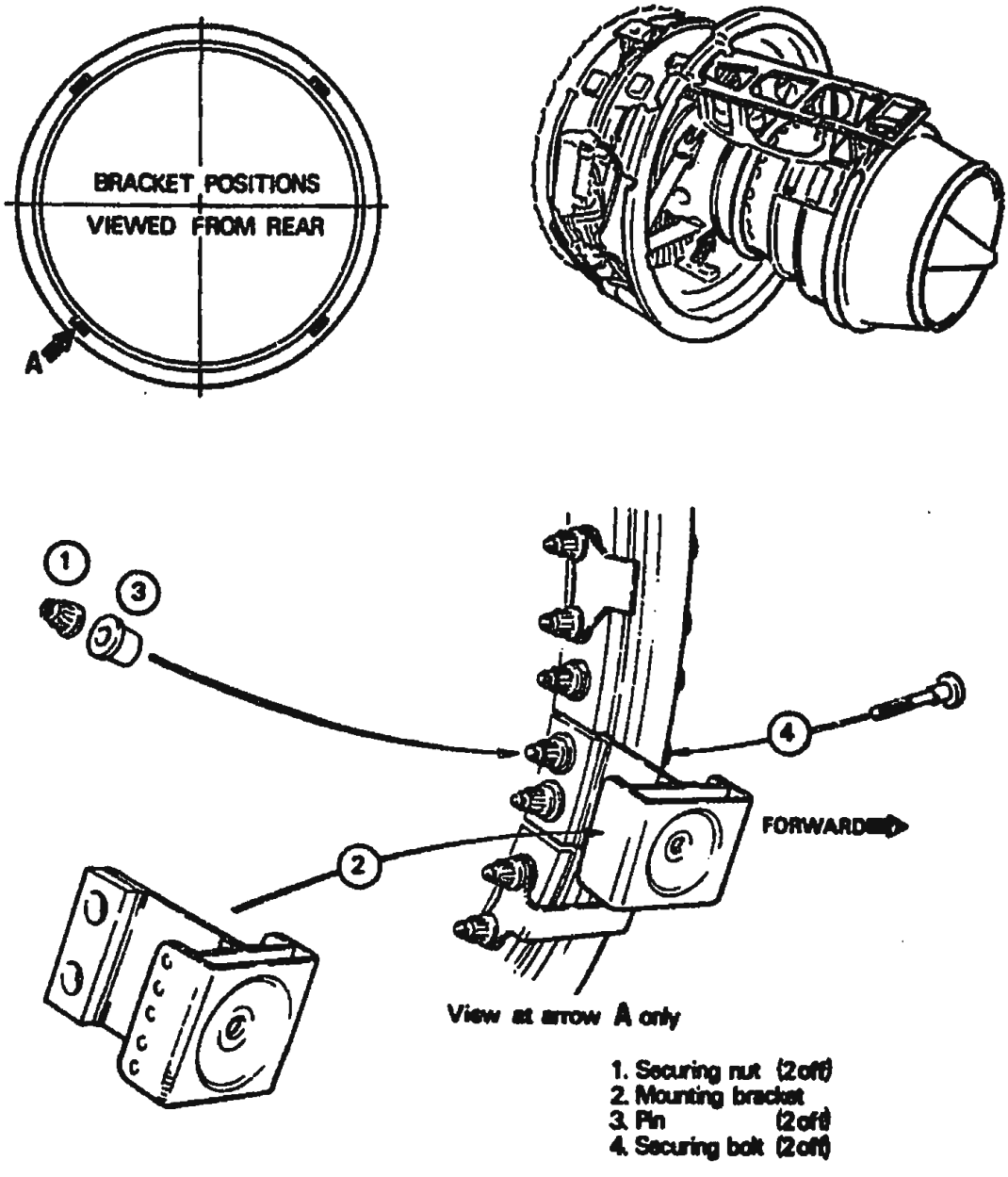
R (3) Position work mats in cold stream duct.

R (4) Remove compressor section fairings (Ref. 72-03-00)

R (5) Refer to fig.401, remove nuts (1), pin (3) and bolts
R (4) and remove bracket (2).

R On R.H. upper and lower bracket positions, remove
R nuts (1). Note position of igniter lead brackets
R then remove igniter lead brackets, mounting bracket (2),
R pin (3) and bolts (4). Leave igniter lead brackets
R attached to igniter leads.

R (6) Remove protective work mats.




R Compressor section fairing mounting brackets removal/installation
R Fig.401

R B. Install support brackets.

R (1) Equipment required:

R 289200 or C 4G 4342 Protective work mats
R *Small, clean brush*

R (2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Dry film lubricant | E.3699 (PL.94) Molykote X.106 | E.3666 (PL.94) Molykote X.106 | 467 4/6 |
| | | Electrofilm 77/S | 4/7 |

R (3) Ensure thrust reverser system is deactivated and tagged as detailed in operation 1.A.(2).

R (4) Position working mats in cold stream duct.

R (5) Refer to fig.401, brush apply a thin coat of dry film lubricant to threads and abutment faces of bolts (4) and nuts (1).

R (6) Fit bolts through intermediate and H.P. module flange while lubricant is still wet and fit pins (3).

R (7) Position bracket (2) on bolts and secure with nuts (1) while lubricant is still wet.

On R.H. upper and lower bracket positions, repeat operations (5) and (6); position bracket (2) on bolts (4) and then position igniter lead brackets on bolts and secure with nuts (1).

R (8) Fit compressor section fairing (Ref. 72-03-00).

R (9) Remove protective work mats.

R (10) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00).

R 2. Removal/Installation H.P. System Module Attachment Bolts

R Referenced Procedures

R 72-03-00 Gas Generator Fairings - Removal/Installation
R 78-30-00 Thrust Reverser System - Servicing

R A. Equipment required:

R 289200 Protective work mats
R HU.19036 Impact extractor
R Small, clean brush

R B. Material required:

| | | | |
|---|---|---|---|
| R | | British spec. | |
| R | Dry film lubricant | E.3699 | Electrofilm 77/S |
| R | Degreasing fluid | B.S.4487:1969 | Genklene |

R C. WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN
R FORWARD THRUST POSITION (REF.78-30-00) WHILE
R WORK IS IN PROGRESS.
R Deactivate and tag thrust reverser and associated systems and
R fit thrust reverser mechanical locks (Ref.78-30-00).

R D. Position work mats in cold stream duct.

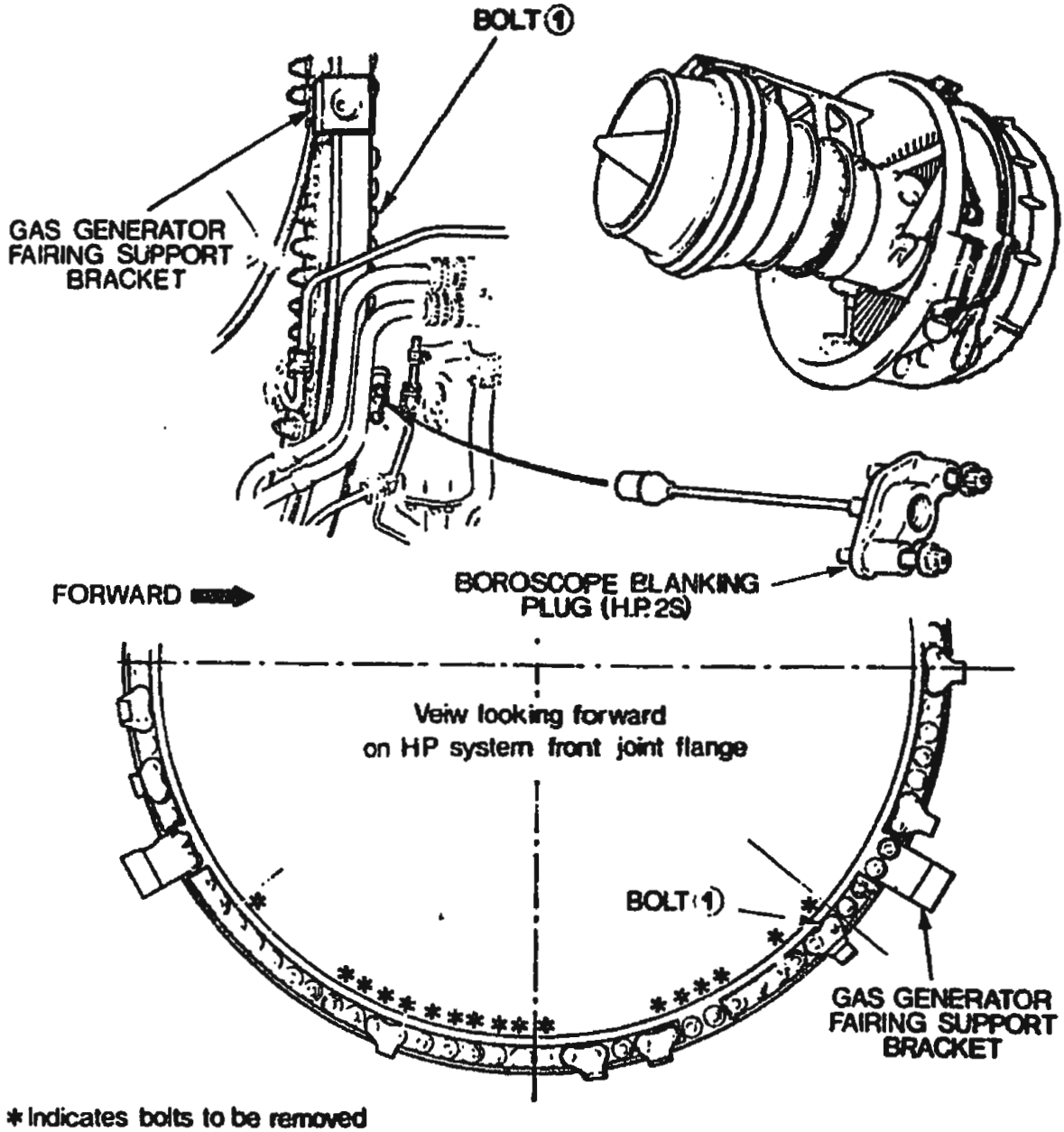
R E. Remove compressor section right and left-hand lower
R fairings and right-hand rear fairing (Ref. 72-03-00).

R F. Refer to fig.402, release bolts securing boroscope blanking
R plug (H.P.2S) then using impact extractor withdraw blanking
R plug from intermediate case.

R G. Remove nut and bolt (1), retain nut.

R H. Brush apply a thin coat of dry film lubricant to threads
R and abutment face of new bolt and to threads and abutment
R face of nut.

R J. Fit bolts through intermediate and H.P. system module
R flanges and secure with nut while lubricant is in a wet
R condition.




R H.P. system module attachment bolts removal/installation
R Fig.402

R K. Working in a clockwise direction (viewed from rear) repeat
R operations G. through J. for each of the remaining 16
R D-headed bolts indicated on fig.402.

R L. WARNING: WHEN USING DEGREASING FLUID AVOID SKIN CONTACT
R AND INHALING THE VAPOUR.
R Using degreasing fluid, clean plug end and also mating
R faces of boroscope blanking plug and intermediate case then
R allow to dry.

R M. Brush apply a thin coat of dry film lubricant to location
R surface of plug end and also to mating faces of blanking
R plug and intermediate case.

R N. CAUTION: ENSURE BOROSCOPE BLANKING PLUG IS CORRECTLY
R FITTED AND SECURED. FAILURE TO DO SO CAN RESULT
R IN ENGINE DAMAGE.
R While lubricant is still wet, position blanking plug in
R intermediate case and secure with bolts.

R P. Fit compressor section right and left-hand lower fairings
R and right-hand rear fairing (Ref. 72-03-00).

R Q. Remove work mats from cold stream duct.

R R. Unlock and reactivate thrust reverser and associated systems
R (Ref.78-30-00).

# HIGH SPEED EXTERNAL GEARBOX MODULE - REMOVAL/INSTALLATION

## MODULE 06

### 1. General

On completion of assembly, joint flanges, securing features and any areas where surface protection is damaged or deteriorated must be reprotected by applying air-drying enamel of the appropriate colour. The air-drying enamels required are listed in 70-42-12.

For ease of reference all illustrations are grouped together at the end of this section.

A. Equipment required:

| | Part Number | Description |
|---|---|---|
| | Lockheed Aircraft Model B896 | Adaptor (handling) |
| | Blackhawk Company T2 | Jack (transmission) |
| | UT.818 | Wrench |
| | CP.20132/3 or CP.30110/1 | Cradle/trolley (slinging) |
| R | CP.21599/1 | Sling (beam) |
| | SPC.1007 | Stand (transportation) |
| | XUT.30827 or HU.20606 | Wrench ('C' type) |
| R | CP.30249 | Adaptor (centre) |
| R | CP.30248 | Adaptor (left hand) |
| R | CP.30250 | Adaptor (right hand) |
| R | CP.30262 | Slinging cradle |

B. Service Bulletins referred to:-

S.B.73-2232 - Fitting of self consuming drains system.
S.B.76-2959 - Introduction of a support bracket for fuel flow regulator (FFR) box assembly.
S.B.72-2073 - Retention of H.P. tacho generator by bolts.
S.B.72-2946 - Transfer drive tube with quadrant clamp retainer.
S.B.76-3364 - Introduction of modified steady bracket for fuel flow regulator box assembly.
S.B.72-3158 - Improved retention and spline lubrication of radial drive quillshaft.
S.B.71-2565 - H.S. external gearbox gravity oil filler. Scupper drain tube.
S.B.71-2917 - H.S. gearbox gravity oil filler. Extended scupper drain tube.
S.B.72-2435 - Outer tube with location check markings.
S.B.72-4689 - Crossed over L.P. turbine rear bearing and internal gearbox oil return tubes.
S.B.73-5160 - Introduction of Centrisep Air Cleaner
S.B.72-5240 - Introduction of gasket seal between (F.C.T.S.) box and input bevel housing.
S.B.73-4404 - L.P. fuel tube from S.O.V. to H.P. fuel pump, revised routing.
S.B.72-3878 - Deletion of support bracket on combined fuel pump and fuel flow regulator.
S.B.75-5250 - Repositioned H.P.3 bleed valve control solenoid.
S.B.72-6928 - Strengthened support bracket for hydraulic tubes mounting bracket and L.T. harness.

C. Referenced Procedures:

| | | |
|---|---|---|
| R | 12-13-01 | Hydraulic Replenishing - Servicing |
| R | 24-11-01 | I.D.G. - Removal/Installation - Adjustment/ Test. |
| R | 24-21-05 | Generator Control Unit - Removal/Installation. |
| R | 24-41-00 | External Power/Ground Service System - Maintenance Practices. |
| R | 29-11-07 | Engine Driven Hydrualic Pump - Maintenance Practices. |
| R | 70-01-07 | Module Identification and Interchangeability. |
| R | 70-02-01 | Identification, Lubrication and Fitting of Rubber Sealing Rings. |
| R | 70-42-12 | Local Surface Protection. |
| R | 70-51-00 | Torque Tightening Technique - Standard Practices. |
| R | 70-00-00 | Power Plant - Adjustment/Test. |
| R | 72-01-00 | Oil System - Servicing. |
| R | 72-03-00 | Gas Generator Fairings - Removal/Installation. |
| R | 72-60-00 | Accessory Section - Maintenance Practices. |
| R | 72-62-00 | Transfer Drive Tube and Quillshaft - Removal/ Installation. |
| R | 73-11-01 | Low Pressure Fuel Pump - Removal/Installation. |
| R | 73-21-01 | Fuel Flow Regulator - Removal/Installation. |
| R | 75-32-01 | H.P. Compressor Bleed Valve Control Unit - Removal/Installation. |
| R | 76-11-02 | Engine Power and Thrust Reverser Control Linkage - Removal/Installation. |
| R | 77-12-03 | H.P. Tachometer - Removal/Installation. |
| R | 79-31-01 | Oil Pressure Transmitter - Removal/ Installation. |
| R | 79-31-02 | Oil Filter Pressure Differential Switch - Removal/Installation. |
| R | 79-31-03 | Low Oil Pressure Switch - Removal/Installation. |
| R | 79-34-01 | Oil Temperature Bulb - Removal/Installation. |
| R | 79-31-01 | Oil Quantity Transmitter - Removal/ Installation. |
| R | 80-11-07 | Engine Pneumatic Starter - Removal/ Installation. |

## 2. Prepare to Remove External Gearbox Module

A. De-activate electrical supplies as follows:

(1) Combined Fuel Pump - On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag appropriate FUEL CONT AMP circuit breaker.

(2) On pilots centre console, zone 210, place appropriate Fuel Control Amplifier Test Switch in OFF position.

(3) Fuel Flow Regulator - On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag appropriate FUEL FLOW circuit breaker.

(4) Oil Pressure Transmitter - Open relevant circuit breaker to isolate electrical supply to oil pressure indicating and warning system.

NOTE: This operation also isolates electrical power from the Oil Filter Pressure Differential Switch and the Low Oil Pressure Warning Switch.

(5) Oil Temperature Bulb - Open relevant circuit breaker to isolate electrical supply to oil temperature indicating system.

(6) Pneumatic Starter - On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag applicable START AIR VALVE circuit breaker.

(7) On pilots overhead circuit breaker panel CB1, zone 210, open and tag circuit breakers as follows:

FUEL SHUT OFF VALVE

Engine 1,2,3 (D10,11,12), PR1 2 (D14)

FIRE EXTINGUISHER

ENG.1 MAIN and ALTN (C10,11)
ENG.2 MAIN and ALTN (C12,13)
ENG.3 MAIN and ALTN (C14,15)

(8) On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag circuit breakers as follows:

FUEL SYSTEM

| | |
|---|---|
| ENG.1 | EMER & L x FEED (T7) |
| ENG.2 | SEC EMER C X FEED (T10) |
| ENG.3 | EMER & R X FEED (T13) |

(9) On pilots overhead circuit breaker panel CB1, zone 210, verify that applicable circuit breaker HYD PUMP FIREWALL SHUT-OFF VALVE CONT (L15-L18) is closed.

(10) Turn on electrical power (Ref. 24-41-00).

(11) Close applicable hydraulic firewall shut-off valve by pulling the Fire Emergency Shut-off Control (FIRE-PULL handle) on pilots overhead control panel in zone 210.

R (12) Open and tag circuit breaker closed in Step (9).

3. Remove Gearbox Mounted Accessories

A. Remove combined fuel pump (Ref. 73-11-01).

B. Remove fuel flow regulator (Ref. 73-21-01).

C. Drain oil tank and high speed external gearbox (Ref. 72-01-00).

D. Remove oil pressure transmitter (Ref. 79-31-01).

E. Remove low oil pressure warning switch (Ref. 79-31-03).

F. Remove transfer plate - engines with S.B.72-4689

R (1) Disconnect tube 7 (Fig.401) at transfer plate.

(2) Remove transfer plate and retain for fitment to replacement gearbox. Discard old seals.

G. Remove oil filter pressure differential switch (Ref. 79-31-02).

H. Remove oil temperature bulb (Ref. 79-34-01).

I. Remove oil quantity transmitter (Ref. 79-37-01).

J. Remove pneumatic starter (Ref. 80-11-07).

K. Remove engine driven hydraulic pumps (Ref. 29-11-07).

L. Remove integrated drive generator and Q.A.D. ring

(1) Remove integrated generator (I.D.G.) (Ref. 24-11-01).

(2) Refer to fig.402 release and remove Q.A.D. ring adapter plate securing screws.

(3) Remove Q.A.D. ring assembly, seal ring and gasket.

M. Remove F.F.R. flexible throttle control system (F.T.C.S.) box and linkage (Ref. 76-11-02).

N. Remove H.N. compressor bleed valve control unit (Ref. 75-32-01).

O. Remove H.P. tachometer generator (Ref. 77-12-03).

4. Disconnect/Remove Associated Tubes and Fittings

R A. Refer fig.401, disconnect tubes numbered 1 to 8 as applicable, leaving brackets attached to harness.

Engines with S.B.72-6928 retain spacers (3 off).

B. Remove starter oil drain tube, fig.403.

R C. Remove accessories vent tube number 2 dependant on engine
R position.

D. Disconnect essential services loom

(1) Refer to fig.404, disconnect clips from support brackets and support loom clear of gearbox.

E. Disconnect general services catagory 2 harness

(1) Refer to fig.405 disconnect clips from support brackets and support harness clear of gearbox.

F. Disconnect tubes 1 and 2

(1) Refer to fig.406 release end connectors of tubes 1 and
R 2 at services disconnect platform.

G. Remove oil filler drain tube

(1) Refer to fig.407, release clip securing tube to oil filler.

(2) Release support clips at positions marked 'A', then remove tube.

R H. Remove compressor section fairings (Ref.72-03-00).

5. Remove High Speed External Gearbox Module

A. Disconnect transfer drive tube and quillshaft (Ref. 72-62-00).

B. Position and fit tooling

(1) Position slinging cradle/trolley under gearbox module.

(2) Attach hoists to slinging cradle at centre of gravity of cradle.

(3) Hoist slinging cradle to position on external gearbox and secure cradle gearbox.

(4) Transfer hoists to lifting points at centre of gravity of combined cradle and module.

C. Lower module and slinging cradle

R (1) Refer to fig.408 remove bolts and spacers securing suspension links to both sides of gearbox.

(2) Lower module and slinging cradle to ground.

(3) Disconnect hoists.

6. Inspect Gearbox Module/Fancase Interfaces and Non-Modular Parts

A. Inspect the interfaces.

(1) Inspect the internal splines of the transfer drive quillshaft for wear.

| | |
|---|---|
| Wear that does not reduce width at top of spline by more than 15 per cent | Accept |
| Wear in excess of above limits | Reject |

B. Inspect the non-modular parts.

The following procedures detail the inspection of non-modular parts either removed to gain access or transferred from an unserviceable module to a serviceable module. The inspections should be effected on all parts prior to refitment.

(1) Visually inspect unit or part for leakage, overheating and distortion.

(2) Visually inspect all joint flanges and mating faces for cleanliness and freedom from damage and distortion.

(3) Visually inspect unit or part for evidence of corrosion and deterioration of protective coatings.

(4) Visually inspect unit or part for security of all nuts, bolts, connections and wire locking.

(5) Visually inspect electrical harness for cuts, chafing deterioration and security of attachments.

(6) Visually inspect firewire harness for damage, kinking and security of attachment.

(7) Visually inspect tubes for cracks, dents, nicks, scoring and frettage.

(a) Cracks — Reject

(b) Dents

Smooth dents of large area relative to depth provided the diameter of tube is not reduced by more than 10 per cent at any one point and there are no dents within one tube diameter or 12,7 mm. (0.50in.), whichever is the greater, of tube end fittings. — Accept

| | | |
|---|---|---|
| | Smooth, round-bottomed dents of small area provided:<br><br>- The depth on the outer surface of a bend does not exceed 0,381 mm. (0.015in.)<br><br>- The depth on the remaining surface of the tube does not exceed 0,635 mm. (0.025in.)<br><br>- They are not within one tube diameter on 12,7 mm. (0.500in.), whichever is the greater, of tube and fitting | Accept |
| (c) | Nicks | |
| | Nicks not exceeding 0,107 mm. (0.004in.) in depth | Accept |
| (d) | Scoring | |
| | Light scoring | Stone/hand polish 70-42-11, FRS.3253 |
| | Heavy scoring | Reject |
| (e) | Frettage - | |
| | Frettage to a depth not exceeding 0,177 mm. (0.007in.) on outer surface of a bend or 0.254 mm. (0.010in.) on remainder of tube surface | Accept |

R 7. Install High Speed External Gearbox

Refer to module identification and interchangeability 70-01-07 to ensure that standard of replacement module is compatible with those to which it is to be fitted.

A. Ensure appropriate systems are deactivated and tagged as detailed in 2.A.(1) through (12).

B. Prepare replacement gearbox for installation

(1) Transfer tubes 1, 2 and 3 in fig.406 to replacement module.

(a) Remove tubes 1, 2 and 3 from removed module.

(b) Apply jointing compound to mating faces of tubes and gearbox; allow to air dry for ten minutes.

(c) Position tube 3 to gearbox and secure with eight bolts.

(d) Position tube 2 on gearbox and end connector of tube 3, fit five bolts to secure.

(e) Fit clips to tubes 2 and 3.

(f) Fit new seal ring to tube 1.

(g) Fit tube and bracket to gearbox and secure with bolts.

(h) Torque tighten all end connector and clip bolts to standard loading.

(2) Transfer all blanks and covers from replacement module to removed module.

(3) Engines without S.B.72-3158: remove quillshaft locating plate from input drive housing of removed module, fit new seal ring and locate plate on replacement module (Ref. 72-62-00).

(4) Position replacement gearbox and slinging cradle under engine.

(5) Attach gantry hoists to slinging cradle at centre of gravity of gearbox and cradle.

R C. Fit external gearbox module (Ref. fig.408)

(1) Lift gearbox into position, ensuring gearbox location pin locates in bore in L.P. compressor case.

(2) Fit bolts and spacers to secure gearbox to suspension links.

(3) Torque tighten bolts to 750 lb.ins.

(4) Disconnect hoists and attach to slinging cradle at centre of gravity of cradle.

(5) Release slinging cradle securing details and lower cradle to ground.

(6) Remove slinging cradle from working area.

D. Connect transfer drive tube and quillshaft (Ref. 72-62-00).

8. Fit External Gearbox Module Mounted Accessories

CAUTION: JOINTING COMPOUND MUST BE APPLIED TO MOUNTING FACES OF ALL COMPONENTS OR PARTS WHICH, WHEN MOUNTED ON THE GEARBOX, RESULT IN METAL JOINTS OF DISSIMILAR NATURE I.E. MAGNESIUM (GEARBOX) TO ALUMINIUM (H.P. TACHOMETER GENERATOR GASKET); FAILURE TO DO THIS MAY RESULT IN THE FORMATION OF CORROSION. APPLY JOINTING COMPOUND AS DETAILED BELOW.

Apply a thin film of jointing compound to mating face of component or part, remove excess compound and allow to air dry for a minimum period of ten minutes before mounting.

Prior to fitting all parts specified in the following procedure, they are to be inspected as detailed in paragraph 4.

A. Materials required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Lockwire | Staybrite DTD.189A 22 S.W.G. | 21 A.W.G. | 238 |
| Jointing compound Hylomar PL32L | DTD.900/4586 | - | 4/46 |
| Acryloid lubricant (for I.D.G.) | | Rohm and Hass HF 825 | - |
| or | | | |
| Acryloid compound (for I.D.G.) | Lennett Chemicals, Croydon | - | - |

R B. Fit compressor section fairings (Ref. fig.72-03-00)

C. Fit H.P. tachometer generator (Ref. 77-12-03).

D. Fit H.P. compressor bleed valve control unit (Ref. 75-32-01).

E. Fit F.F.R. flexible throttle control system (F.T.C.S.) box and linkage (Ref. 76-11-02).

F. Fit Q.A.D. ring assembly

(1) CAUTION: BEFORE INSTALLING I.D.G. THE Q.A.D. RING MUST BE INSPECTED FOR LUG AND THREAD WEAR. Refer to fig.402, locate Q.A.D. ring with gasket and new seal ring, to I.D.G. mounting face on gearbox, then fit and torque tighten screws to standard load.

NOTE: The following operation is optional.

(2) Lock screws by peening screws into slots in ring assembly.

G. Fit integrated drive generator (I.D.G.) (Ref. 24-11-01).

H. Fit engine driven hydraulic pumps (Ref. 29-11-07).

I. Fit pneumatic starter (Ref. 80-11-07).

J. Install oil quantity transmitter (Ref. 79-37-01).

K. Engines with S.B.72-4689 Install transfer plate

(1) Refer to fig.401 ensure seal ring retainers are fitted then fit new seals to gearbox face.

(2) Position transfer plate on two dowels and press firmly on to gearbox face.

L. Fit low oil pressure warning switch (Ref. 79-31-03).

M. Fit oil pressure transmitter (Ref. 79-31-01).

N. Fit oil filter pressure differential switch (Ref. 79-31-02).

O. Fit oil temperature bulb (Ref. 79-34-01).

P. Fit fuel flow regulator (Ref. 73-21-01).

R Q. Fit combined fuel pumps (Ref. 73-11-01).

9. Fit Associated Tubes and Fittings

A. Connect tubes 1 and 2

R (1) Refer to fig.406 engage end connectors of tubes 1 and 2 at services disconnect platform.

R (2) Torque tighten end connectors to standard load and wirelock (Ref. 71-51-00).

R B. Fit oil filler drain tube

R (1) Ref. fig.407, fit hose and secure with clips.

R (2) Fit support clips at positions marked 'A'.

C. Fit accessories vent tube (engine No.2) or vent tube (engine No.1 and 3)

(1) Refer to fig.403 fit accessories vent tube (engine No.2)

(a) Fit new seal ring to forward end of tube.

(b) Position tube and fit bolts to secure.

(c) Position clips and fit bolts to secure.

R (d) Torque tighten bolts to standard load
R (Ref. 70-51-00).

(2) Fit vent tube (engines No.1 and 3)

(a) Fit new seal ring.

(b) Position tube, fit and torque tighten to
R standard load (Ref. 70-51-00).

D. Fit starter oil drain tube, Ref. fig.403

(1) Fit new seal rings to both ends of tube.

(2) Position tube and fit bolts to secure.

R (3) Torque tighten bolts to standard load (Ref. 70-51-00).

R E. Connect tubes numbered 1 to 8 in fig.401 as applicable

R (1) Fit new seal rings to tubes 1, 3, 4, 5, 6, 7 and 8.

R (2) On engines without S.B.72-6928 fit brackets to tubes 4 and 5.

R (3) On engines with S.B.72-6928 fit bracket and spacers to tube 5 and bracket to tube 4.

R (4) Fit bolts to secure and torque tighten to standard load (Ref. 70-51-00).

R (5) Align and secure tube 7 end connector to tube 6 then
R torque tighten to standard load and wirelock
R (Ref. 70-51-00).

R (6) Fit new gasket to tube 2.

R (7) Fit and torque tighten to standard load (Ref. 70-51-00).

F. Connect general services catagory 2 harness

(1) Refer to fig.405, position harness and secure clips.

R (2) Torque tighten clip bolts to standard load (Ref. 70-51-00).

(3) Connect tighten and wirelock all electrical connectors.

G. Connect essential services loom

(1) Refer to fig.404 position harness and secure clips.

(2) Torque tighten clip bolts to standard load.

(3) Connect, tighten and wirelock all electrical connectors.

H. Remove tags and reactivate systems deactivated in para.2.A.

10. Replenishment and Priming after Installation

A. Fill IDG oil system (Ref. 24-11-01).

B. Prime and bleed hydraulic pump(s) (Ref. 29-11-07).

C. Check quantity of hydraulic fluid and replenish as necessary (Ref. 12-13-01).

D. Replenish engine oil tank with 20 Imperial pints (11.37 litres, 24 U.S. pints).

E. Oil prime external gearbox drive and housing and also gearbox input drive bevel gears. (Ref. 72-60-00).

F. Dry motor engine for 30 seconds (Ref. 71-00-00).

G. Check engine oil level and replenish as necessary.

11. Testing after Installation

A. Perform I.D.G. static disconnect test (Ref. 24-11-01)

B. Refer to 71-00-00 Table 501 and perform tests detailed following 06 Module replacement.

C. During ground run with engine at idle power perform the following:

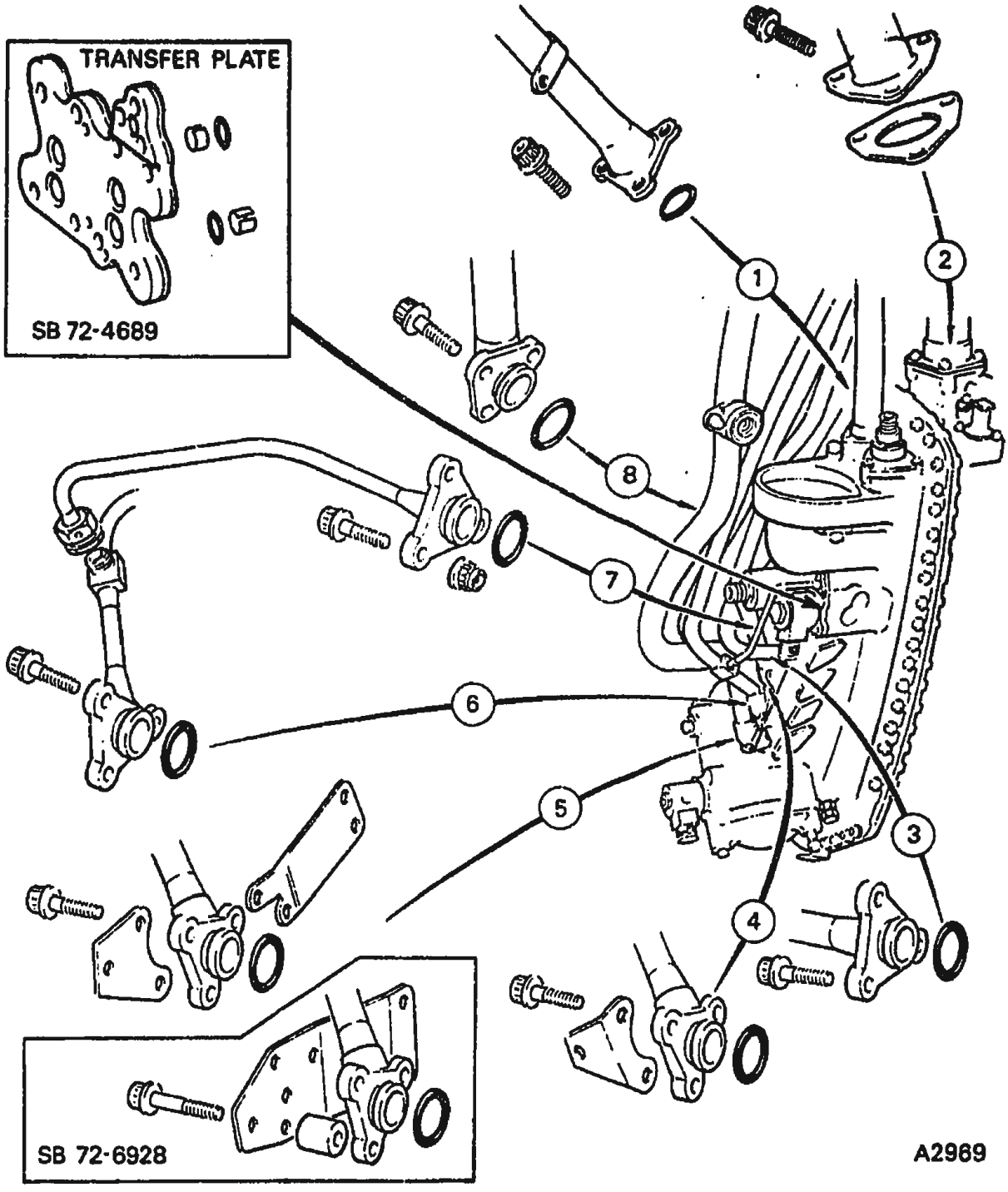
(1) Verify that LOW PRESS light in the IDG DISCONNECT switchlight on Flight Engineer/Second Officers ELECTRICAL control panel, zone 215, goes off by the time the engine speed stabilizes. If the light does not go off, disconnect IDG immediately, shut down the engine and fault - isolate IDG oil system (Ref.24-11-01 Fig.102).

(2) Energize generator, rotate meter selector switch on Flight Engineer/ Second Officers ELECTRICAL control panel to applicable generator and verify that frequency and voltage of output are 400 (±4) Hz and 117 (±2) V ac.

If frequency is not within specified limits, refer to Governor Adjustment (Ref. 24-11-01, Adjustment/Test).

If voltage is not within specified limits, replace corresponding generator control unit (Ref. 24-21-05).

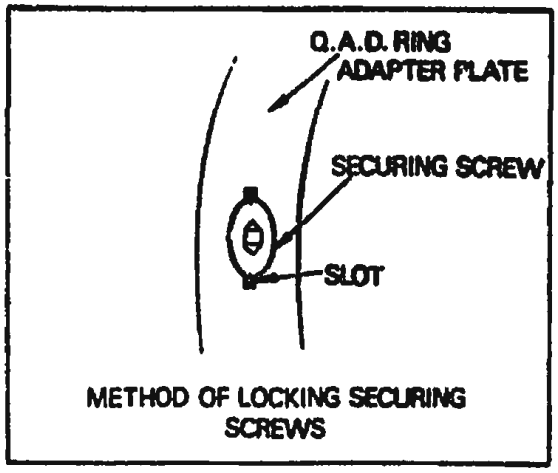
(3) Perform Dynamic Disconnect Test (Ref. 24-11-01).



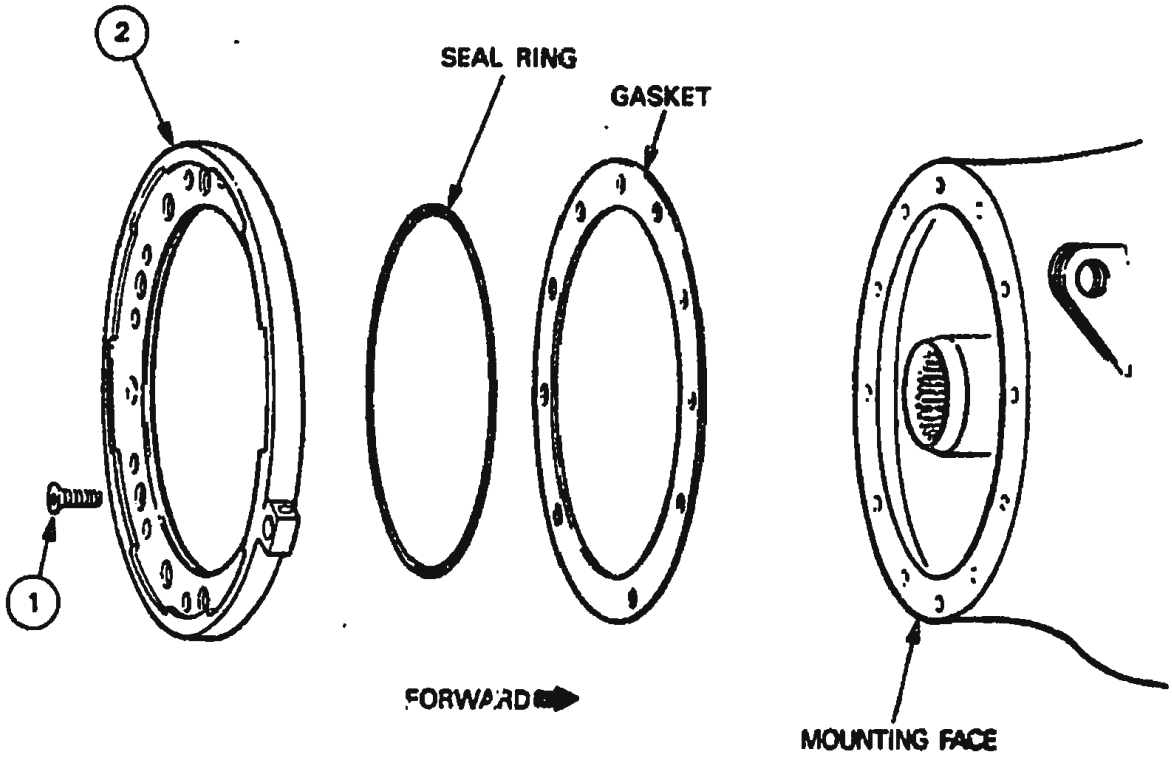

R Remove/Install transfer plate and disconnect tubes
R mounted on oil tank
R Fig.401

EFFECTIVITY: ALL

1. Securing screws
2. Q.A.D. ring assembly

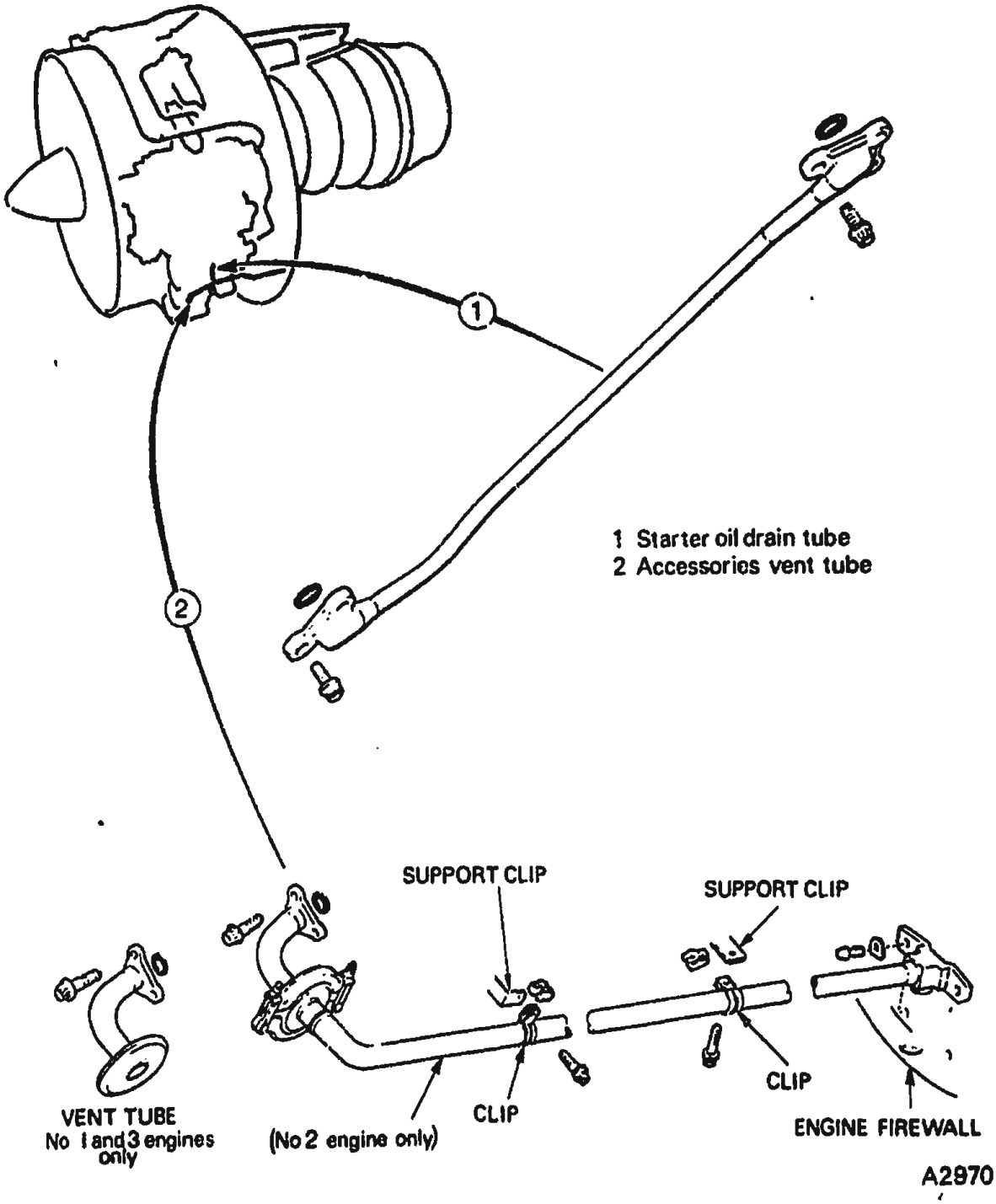



METHOD OF LOCKING SECURING SCREWS

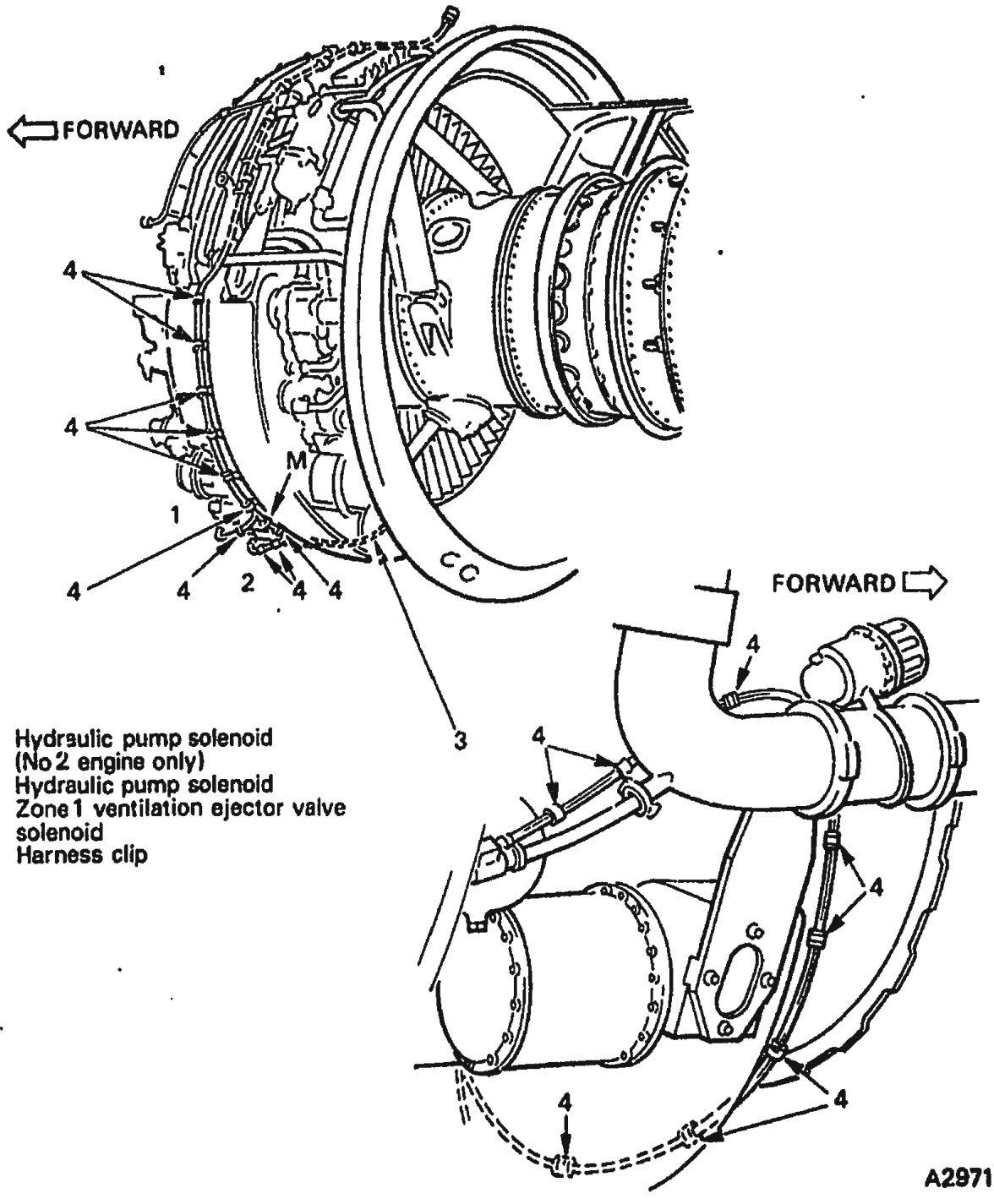



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R Remove/Install Q.A.D. ring assembly
R Fig.402

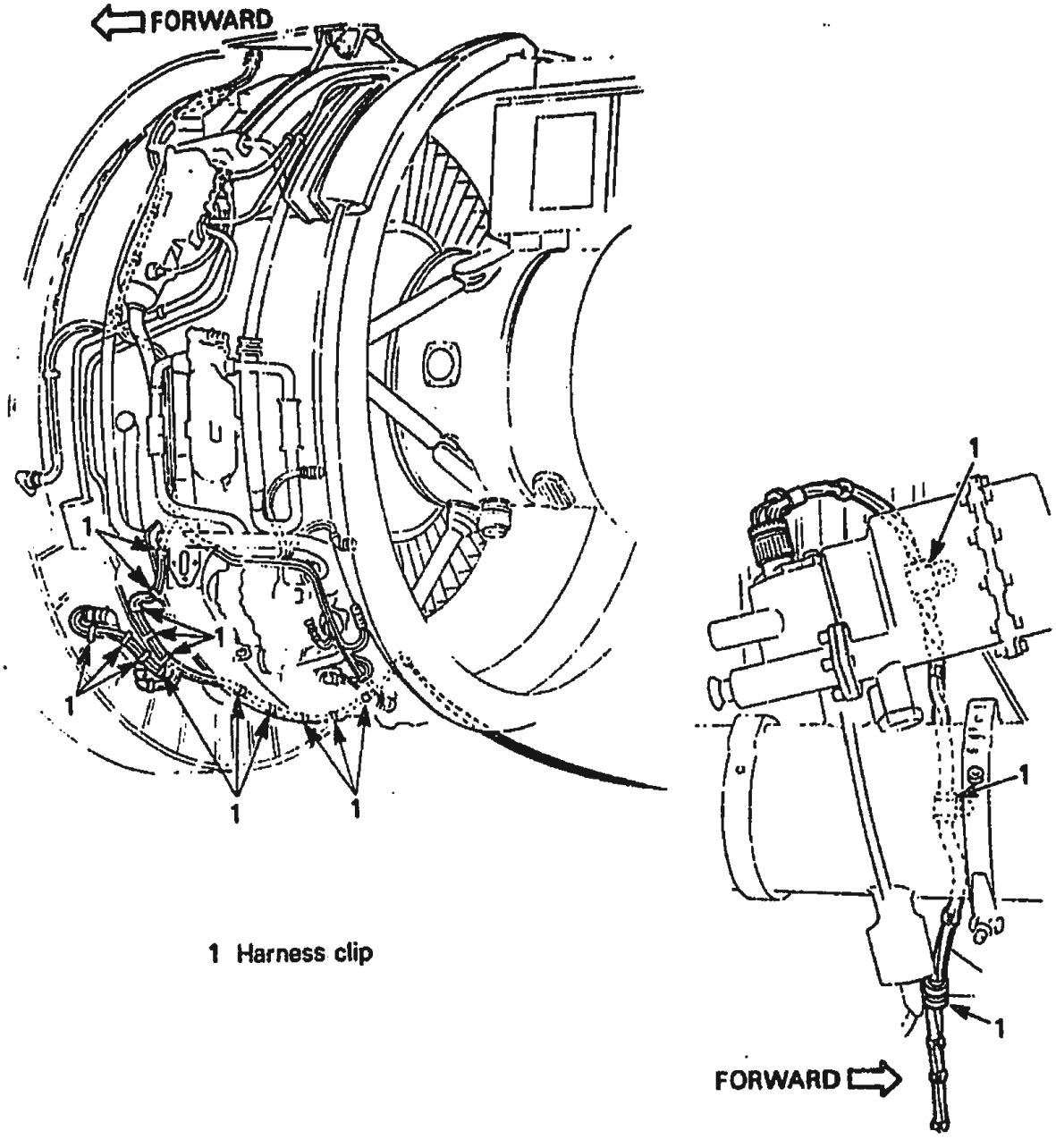



R Remove/Install oil drain tube and accessories
R Fig.403




1 Hydraulic pump solenoid (No 2 engine only)
2 Hydraulic pump solenoid
3 Zone 1 ventilation ejector valve solenoid
4 Harness clip

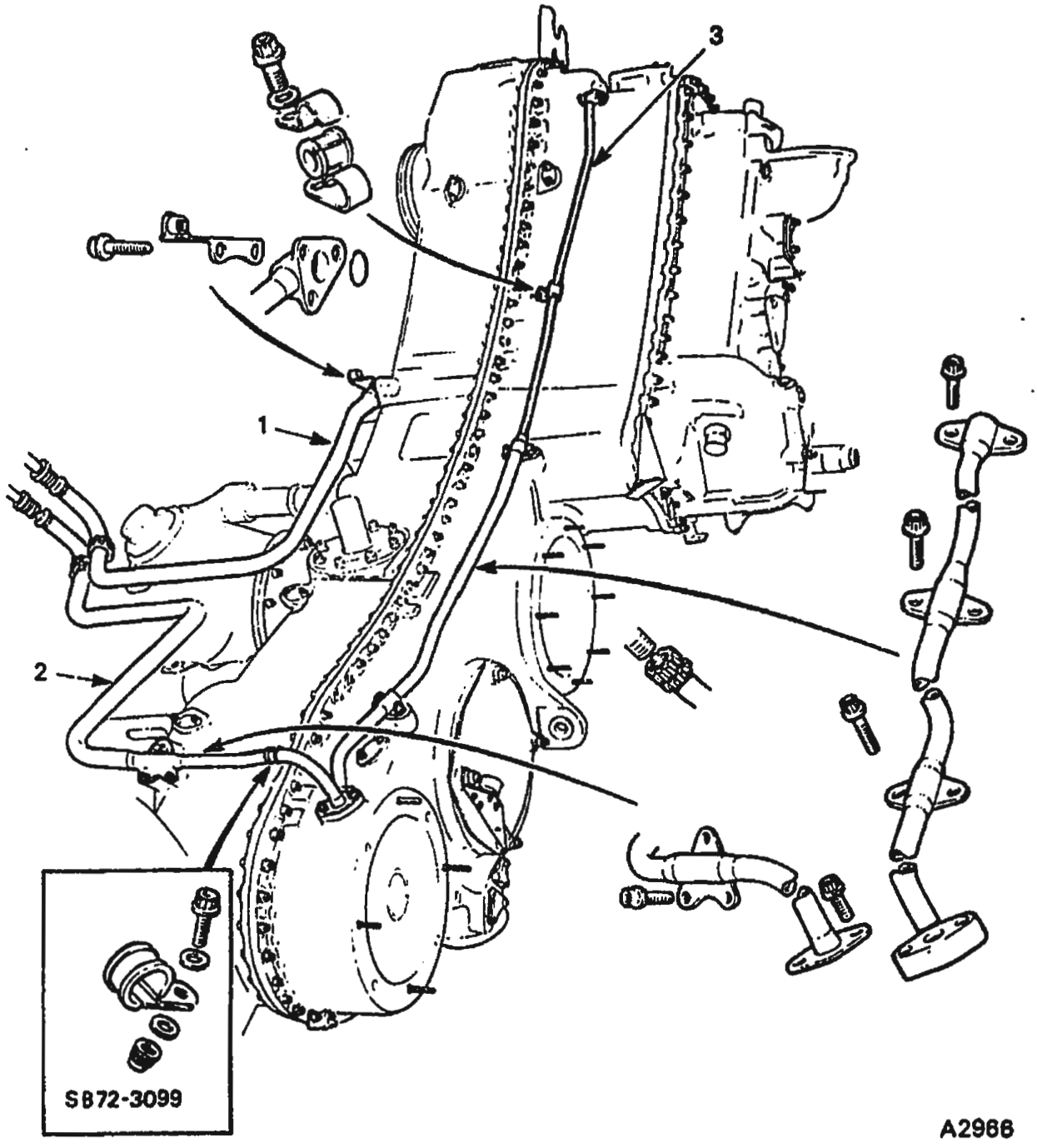
R Essential services loom clipping details
R Fig.404



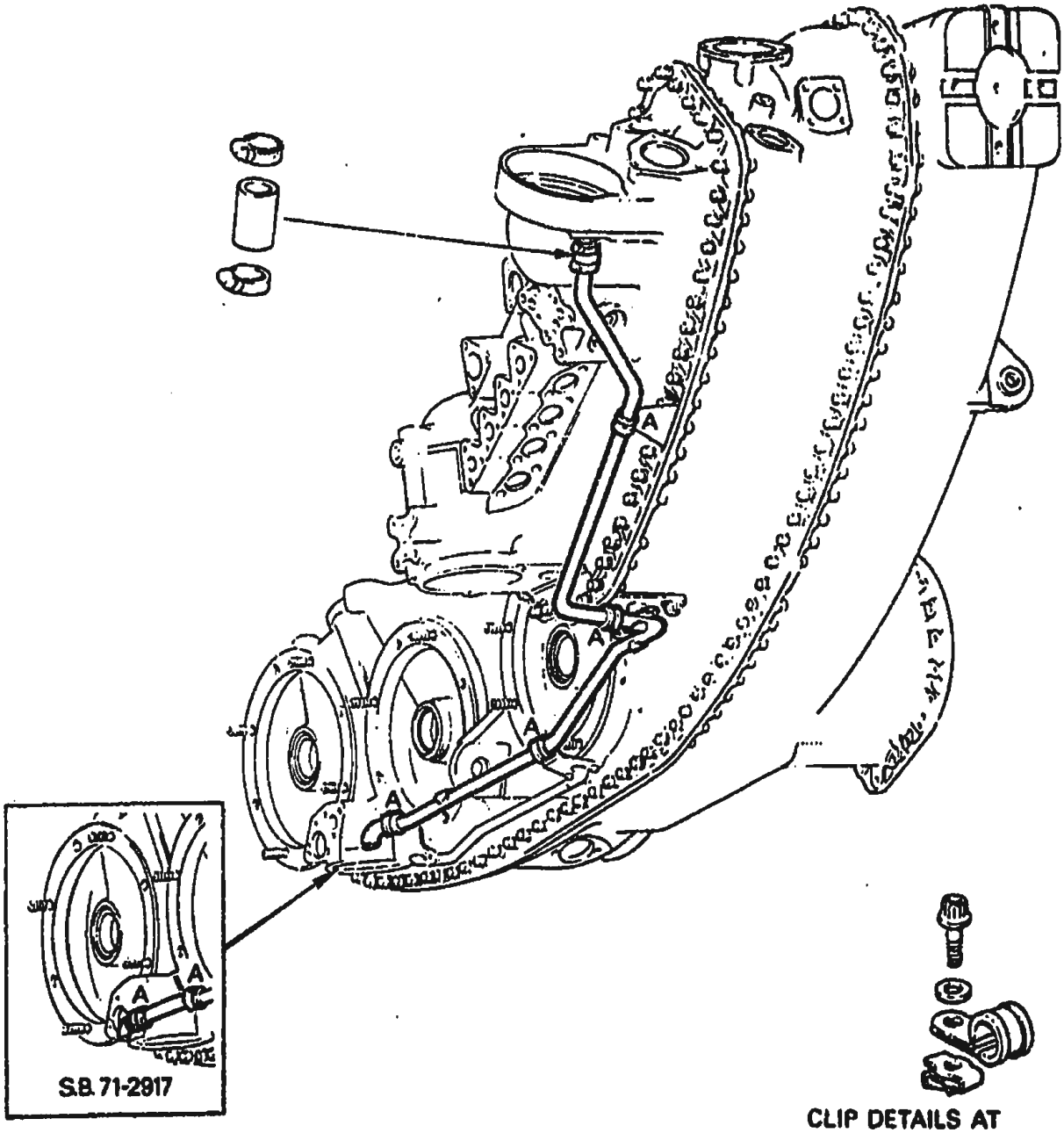

1 Harness clip

A2972

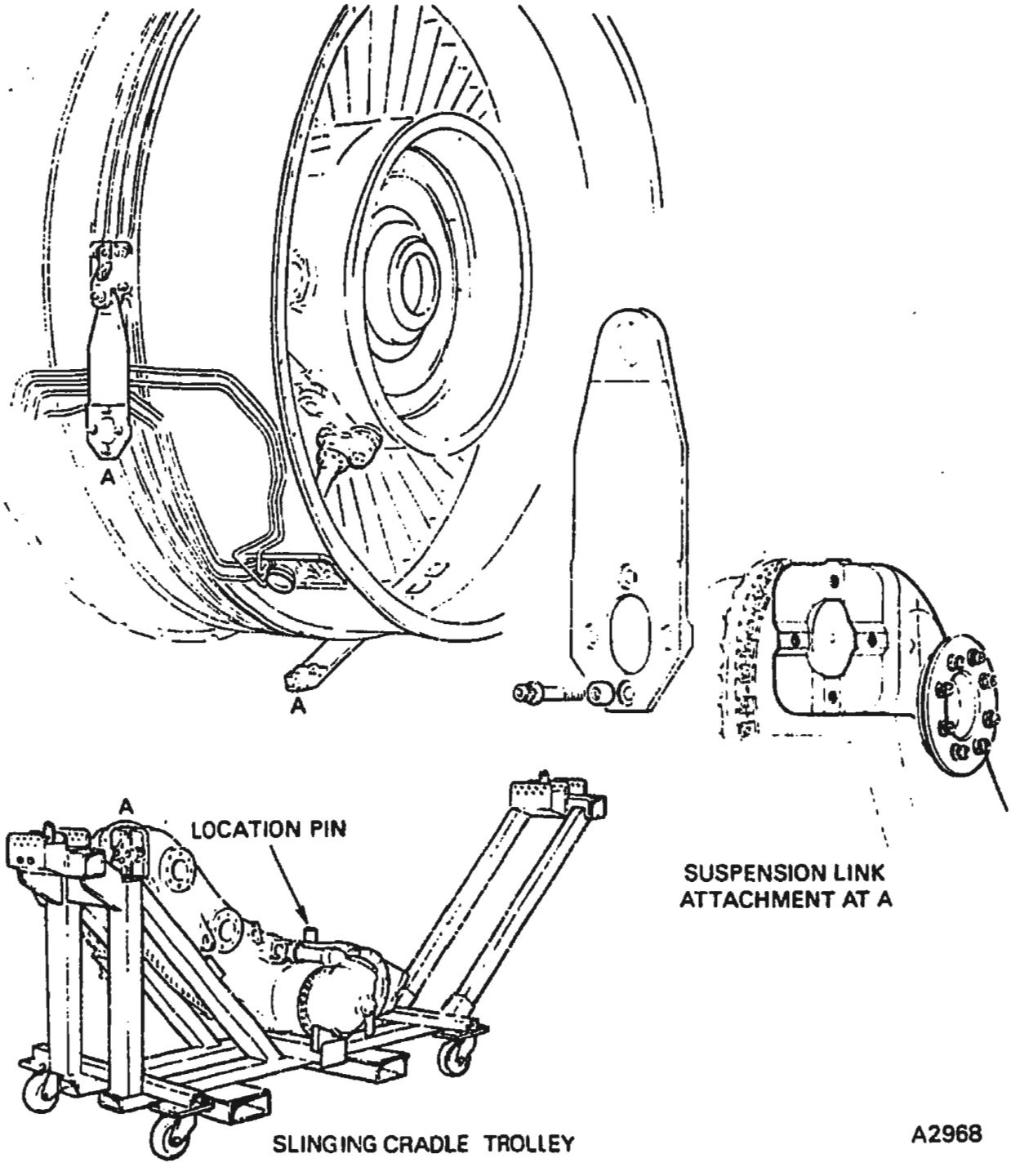
R General services category 2 harness clipping details
R Fig.405




R Disconnect/Connect and transfer gearbox mounted tubes
R Fig.406




R S.B.71-2565 and S.B.71-2917: Remove/Install oil filler drain tube
R Fig.407




Remove/Install gearbox module
Fig.408

# OIL SYSTEM - DESCRIPTION AND OPERATION

## 1. General

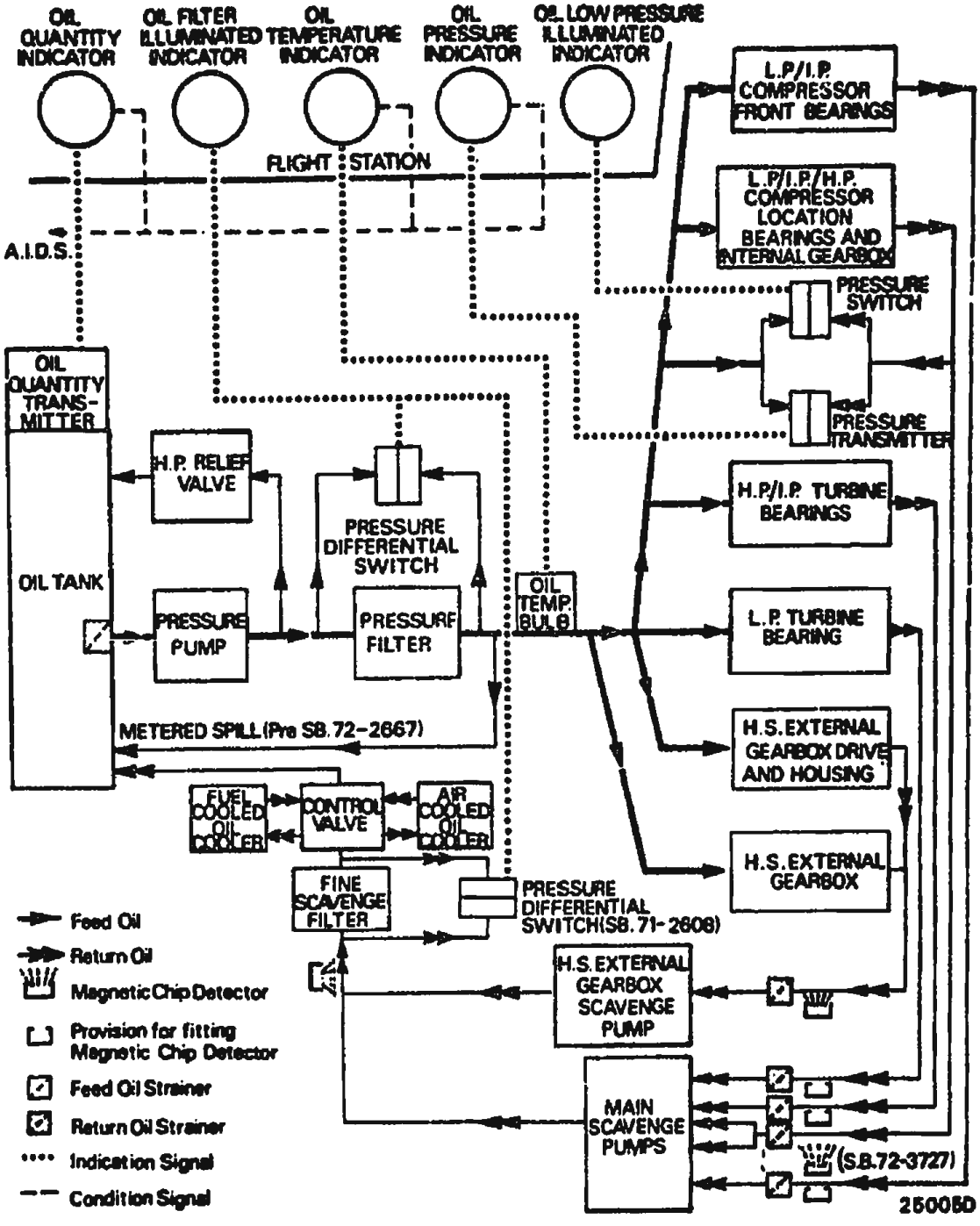
| | |
|---|---|
| System total oil capacity (nominal) | 72.0 U.S. pints<br>60.0 Imperial pints<br>34.1 litres |
| Tank oil capacity (nominal) | 44.0 U.S. pints<br>36.6 Imperial pints<br>20.8 litres |
| Usable oil | 30.0 U.S. pints<br>25.0 Imperial pints<br>14.2 litres |
| Approved oil | Refer to 12-12-01 |

The lubrication and cooling of engine bearings, gears and splines is achieved by using a self-contained, full flow, re-circulatory oil system. The oil system is described in this section except for the following units which are described in the Chapter/Section shown.

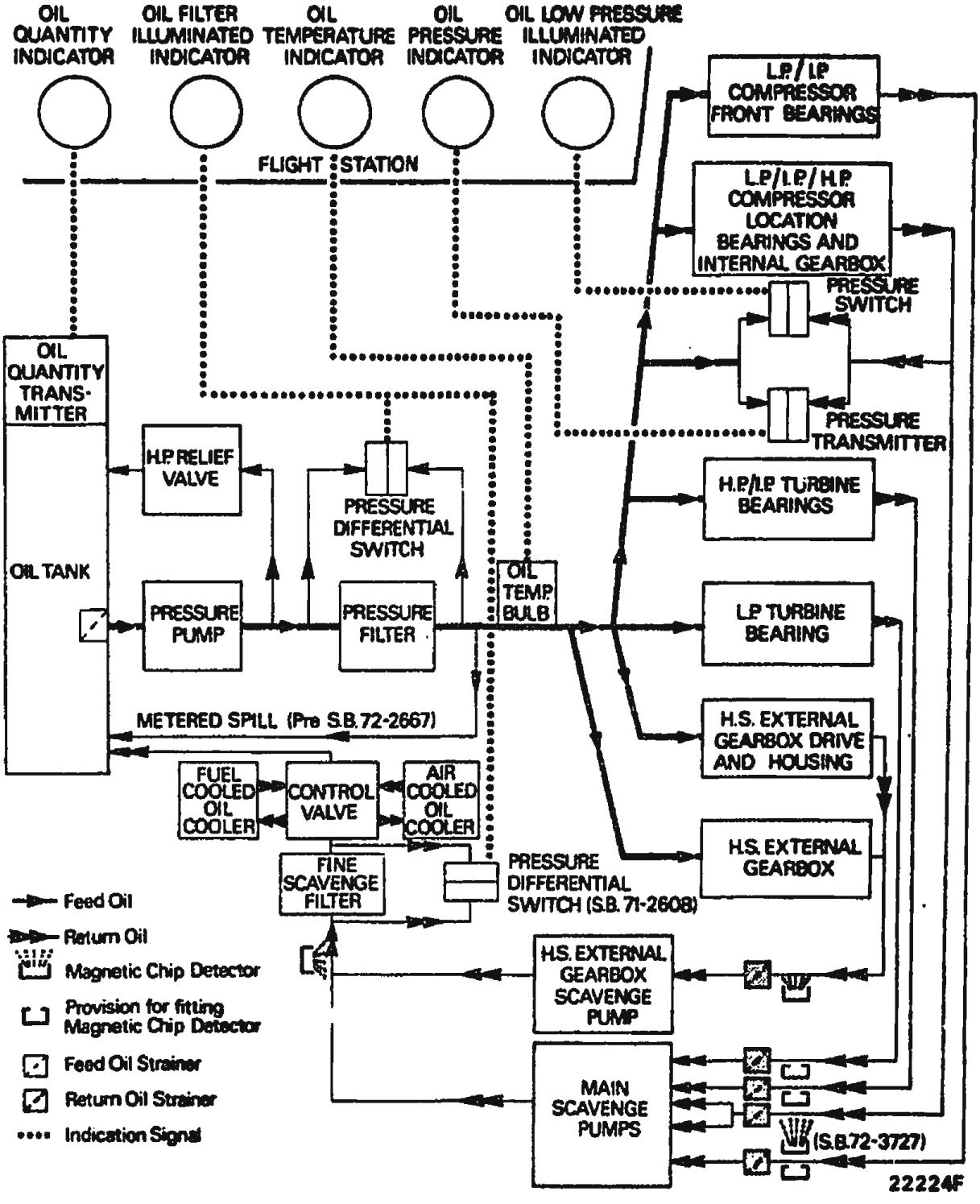
| | |
|---|---|
| Oil pressure transmitter | 79-31-00 |
| Oil low pressure warning switch | 79-31-00 |
| Oil filter pressure differential switch | 79-31-00 |
| Oil temperature bulb | 79-34-00 |
| Oil quantity transmitter | 79-37-00 |

Aircraft incorporating A.I.D.S. - Electrical signals are taken from the oil temperature, pressure and quantity indicators and fed into a data acquisition unit which forms part of the Airborne Integrated Data System (A.I.D.S.) (Ref.31-32-00).

The system is illustrated in fig.1 as a simplified diagram, in fig.7 as a diagrammatic layout and fig.8 provides an external view of units and tubes.




Oil system simplified diagram -
Engines with A.I.D.S.
Fig.1 (Sheet 1)




Oil system simplified diagram -
Engines without A.I.D.S.
Fig.1 (Sheet 2)

Service Bulletins referred to:

71-2565 - H.S. Gearbox Gravity Oil Filler Scupper Drain Tube.
71-2608 - Introduction of Fine Scavenge Filter Differential Pressure Switch.
72-2493 - Deletion of L.P. Turbine Bearing Oil Vent Tube.
72-2667 - Deletion of Oil Spill Jet
72-2860 - Deletion of Oil Tank Dipstick Assembly
72-2919 - Introduction of Turbine Cooling Shroud.
72-3533 - Oil Tank Filler with Additional Fail Safe Seal
72-3727 - Internal Gearbox Oil Return Tube with Magnetic Chip Detector Fitted
72-4689 - Crossed over L.P. Turbine Rear Bearing and Internal Gearbox Oil Return Tubes.
72-5528 - Deletion of Internal Gearbox Scavenge Strainer and Strainer Retention Boss Blanked.
R 72-7654 - Oil Tank Cover - Deletion of Scavenge Strainers.

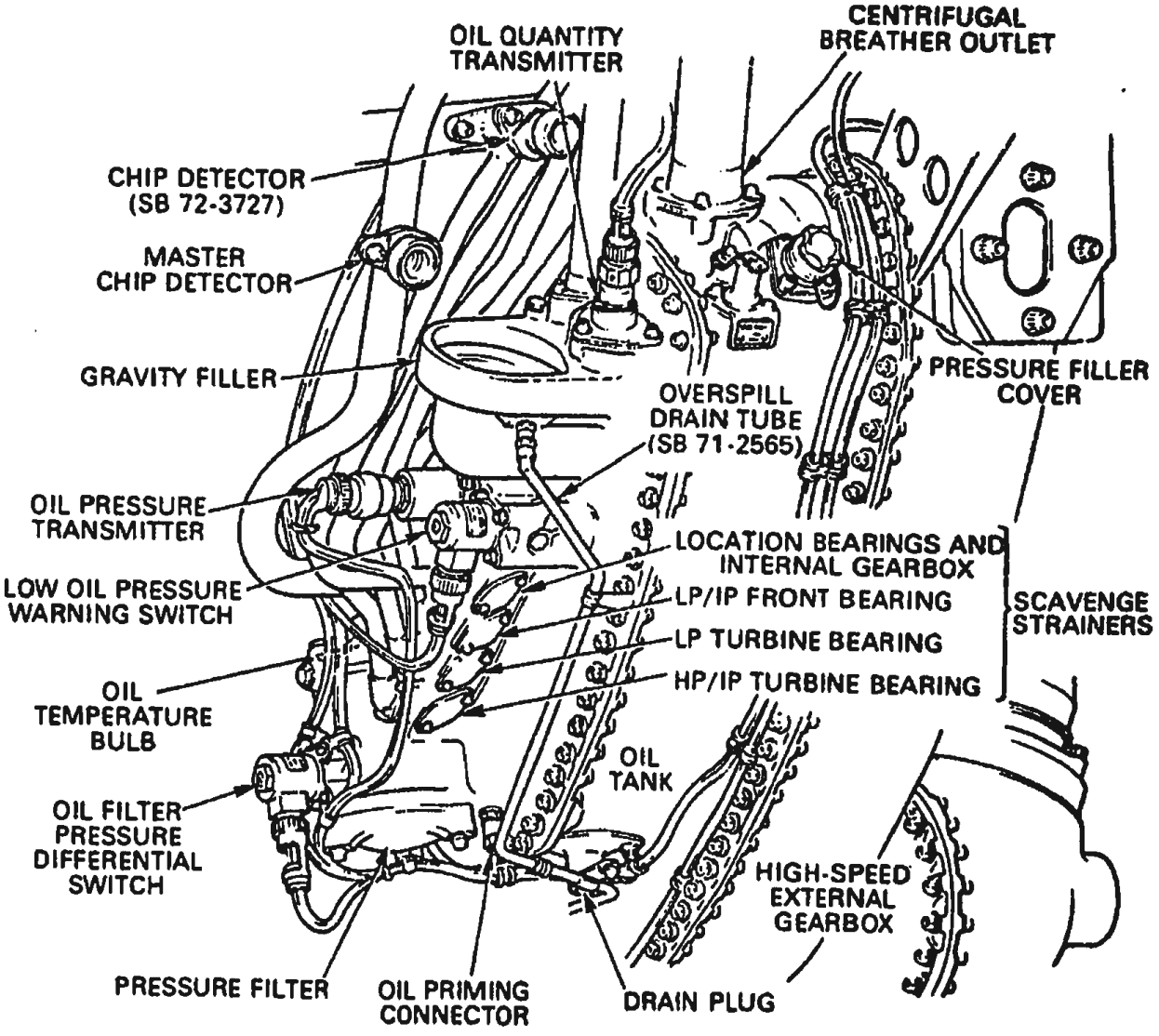
## 2. Description

The oil system (Ref. fig.7) is contained within zones 412, 422 and 432. The system is of the full flow type whereby the required feed oil flow is achieved by pump delivery pressure maintaining a positive pressure drop across the oil jets at all operating conditions.

The system oil supply is contained in an oil tank which is integral with and situated on the front face of the high-speed external gearbox. On engines incorporating S.B.72-3533, a float valve is positioned below the oil filler cap to prevent oil loss should the filler cap be incorrectly fitted or inadvertently left off. Fig.2 illustrates the oil tank external details. On engines incorporating S.B.72-2860, the oil tank dipstick assembly is deleted.

Oil flow is effected by a pump assembly mounted in the oil tank and driven from the external gearbox. The assembly comprises two separate gear pairs forming the pressure pump and the external gearbox scavenge pump, and six gears arranged in series forming a five pump combined discharge system, scavenging the engine main bearing chambers.

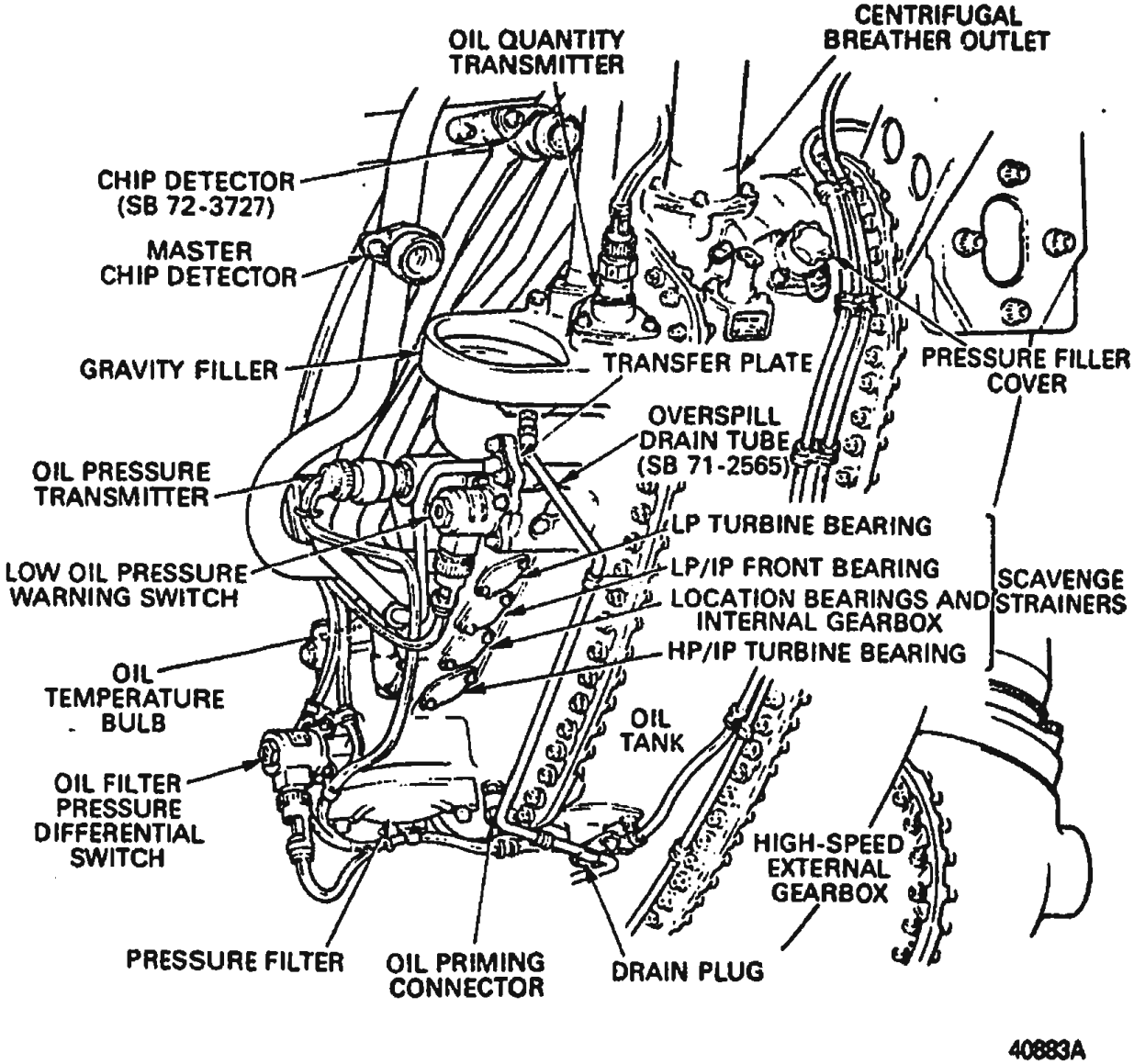
A high pressure oil relief valve of the spring loaded disc type is fitted to prevent excessive system oil pressures. It is non-adjustable and spills directly to the oil tank.




22225F

R Oil tank and chip detector details -
R engines without S.B.72-4689
R Fig.2

EFFECTIVITY: ALL




R Oil tank and chip detector details -
R engines with S.B.72-4689
R Fig.2A

All feed oil passes through a wire wound type pressure filter. Additional filtration is provided by thread type filters upstream of the oil jets at the L.P. system and external gearbox drive and housing bearings, and by plate and gauze filters for the jets at the remaining engine main bearings.

An anti-syphon jet prevents oil syphoning from the oil tank to the external gearbox when the engine is stationary and a metered spill jet is fitted to return excess pressure pump output to the oil tank. On engines incorporating S.B.72-2667, the metered spill jet is deleted.

All gears are provided with jet or splash lubrication. Oil weirs and troughs are fitted at the bevel gearing taking starting loads to ensure adequate initial lubrication. Tappings are provided in the external gearbox for H.P. tachometer generator bearing and integrated drive generator spline lubrication.

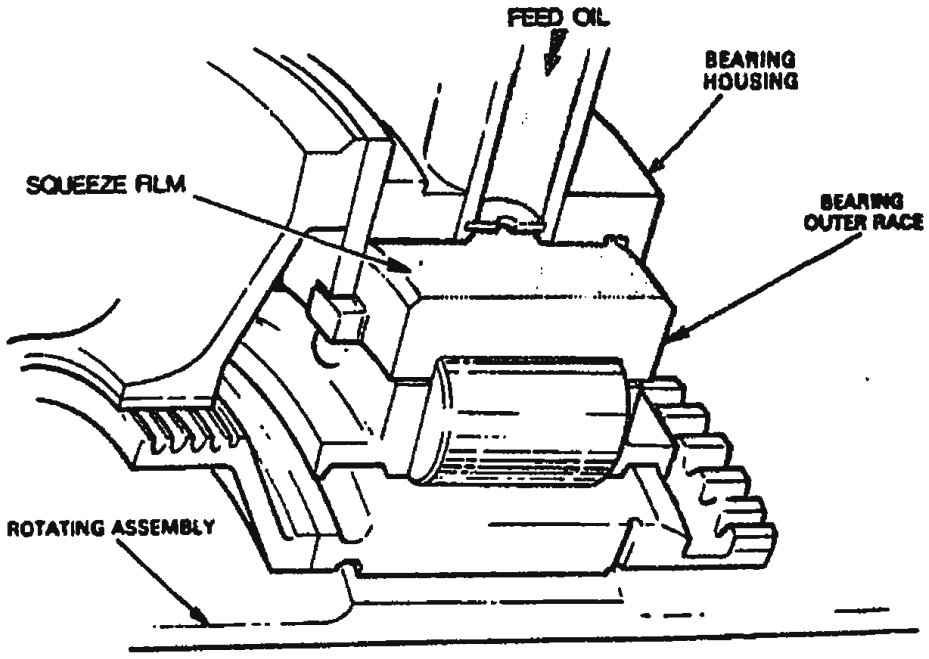
Oil loss from the main shaft bearings is prevented by grooved labyrinth seals pressurised by the sealing air system (Ref. 72-02-00), and by oil filled hydraulic seals.

The engine main roller bearings feature oil 'squeeze film' damping (Ref. fig.3) between the outer race and bearing housing to minimize vibration. This oil also cools the bearing outer race.

To ensure effective squeeze film oil flow during engine starting, the L.P. shaft system bearings are centralized in the squeeze film annulus by a support shoe mounted in a spring support assembly (Ref. fig.4). These assemblies are fitted at the base of the L.P. compressor and L.P. turbine bearing housings.

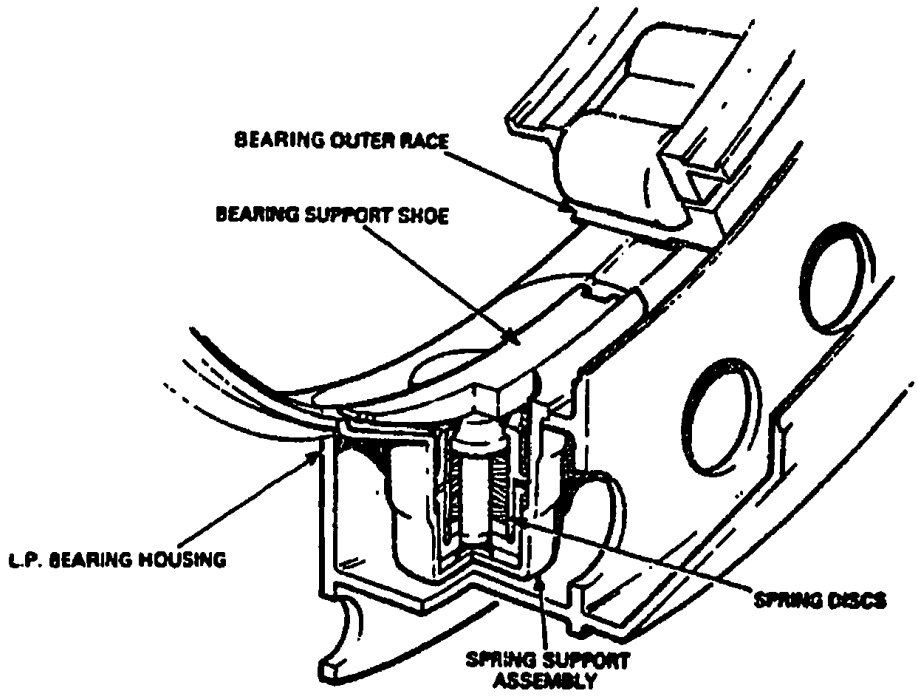
Each main scavenge pump is protected by a gauze strainer and is individually identified on the adjacent tank case. On engines with S.B.72-5528, the internal gearbox scavenge
R strainer has been deleted. On engines with S.B.72-7654 all main
R scavenge pump strainers are deleted. Magnetic chip detectors are fitted at the scavenge pump inlets to sample return oil from individual engine main bearings. Careful analysis of any debris caught can give early warning of bearing failure.

The oil tank and engine main bearing chambers are vented to the external gearbox which in turn is vented to atmosphere through a centrifugal breather (Ref. fig.5).




22228A

Oil squeeze film damping
Fig.3




Spring support assembly
Fig.4

The oil priming connector is located on the oil tank front face adjacent to the pressure filter.

The return oil cooling system, which is protected by a fine scavenge filter, comprises an air-cooled oil cooler, a fuel-cooled oil cooler and a control valve. Oil cooling is effected by the oil being passed through both coolers except at low fuel temperature conditions when oil is passed through the fuel-cooled oil cooler only.

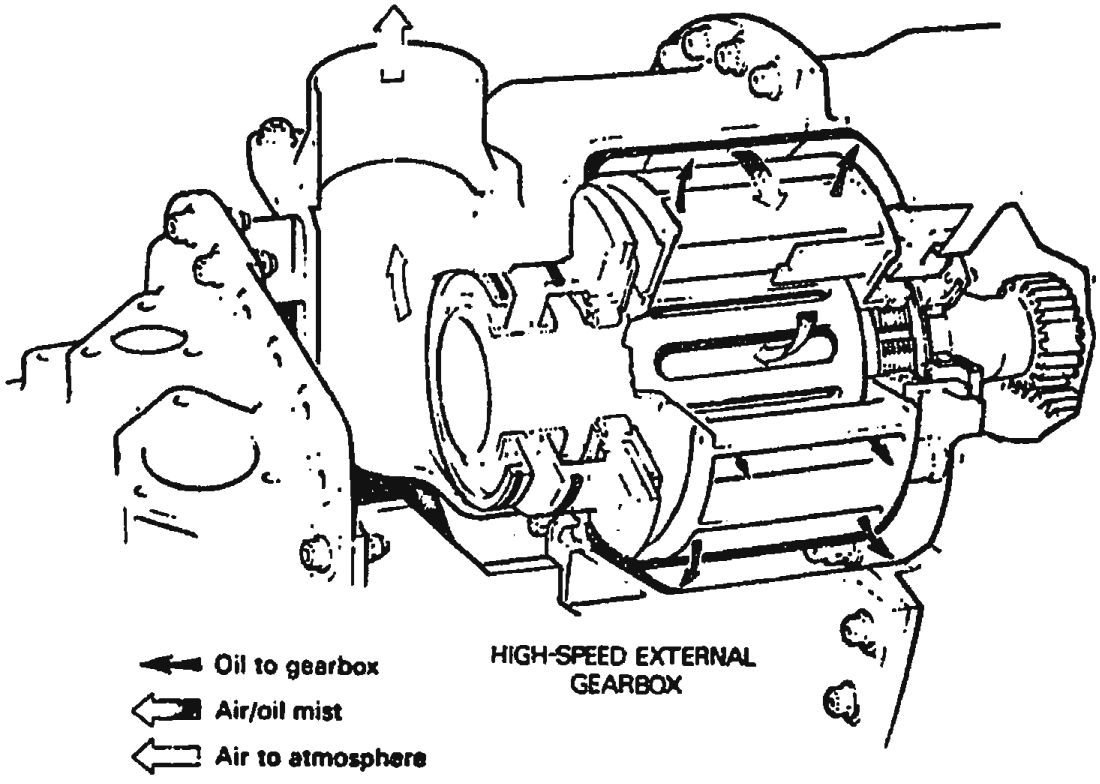
A. Air-Cooled Oil Cooler

The cooler is located on the upper, left-hand side of the L.P. compressor case in zones 412, 422 and 432. It is positioned downstream of the control valve and facilitates a transfer of heat between the return oil and the cooling medium, L.P. compressor delivery air. The L.P. compressor air, taken from the cold stream outlet duct, is passed through the cooler and exhausts to atmosphere. The air flow through the cooler is continuous but the oil flow is dependent upon the temperature of the fuel sensed by the control valve (see I.C.).

The cooler is of the single pass, crossflow type and basically comprises a matrix of corrugated flow passages contained within a case of curved shape conforming to the contour of the L.P. compressor case. Incorporated in the cooler case is a drain plug and oil inlet and outlet connectors. Positioned between these connectors is a by-pass valve which operates if the pressure drop across the unit exceeds a pre-determined maximum.

B. Fuel-Cooled Oil Cooler

The cooler is located on the upper, left-hand side of the L.P. compressor case in zones 412, 422 and 432. It is positioned downstream of the control valve in the return oil system and interposed between the L.P. fuel pump and fuel-cooled P4 air cooler in the L.P. fuel system (Ref. 73-00-00). The cooler facilitates a transfer of heat between the oil and L.P. fuel to effect oil cooling and also fuel heating. The fuel and oil flow through the cooler is continuous.




22228B

Centrifugal breather
Fig.5

The cooler basically comprises a tubular matrix in a cylindrical case. Baffle plates fitted in the case direct the oil in a series of radial passes across the matrix to obtain maximum cooling, while the fuel flows through the matrix in a single pass. The case also accommodates inlet and outlet connectors, the control valve mounting bosses and a by-pass valve. The by-pass valve operates if the pressure drop across the unit exceeds a pre-determined maximum.

C. Control Valve

The valve is located on the upper, left-hand side of the L.P. compressor case in zones 412, 422 and 432. It is positioned downstream of the fine scavenge filter and secured to the fuel-cooled oil cooler. Its function is to direct all return oil through one or both the coolers dependent upon the temperature of the fuel.

The valve assembly basically comprises a cylindrical body accomodating inlet and outlet connectors, mounting bosses and a projecting element head at its upper end. Housed within the valve are a spool and its return spring.

The projecting element head is positioned in the fuel outlet from the fuel-cooled oil cooler and senses fuel temperature. The element responds to changes in fuel temperature and positions the spool, against spring pressure, so automatically controlling the amount of oil cooling/fuel heating within the system.

D. Oil Tubes and Fittings

Rigid tubes incorporating nut and nipple or bolted end connectors are used throughout the oil system. The tube positions on the engine are illustrated in fig.8.

E. Magnetic Chip Detectors

Detectors, that sample return oil to facilitate engine internal condition monitoring, are located in zones 412, 422 and 432. They are positioned on the left-hand side of the L.P. compressor case upstream of the fine scavenge filter, at the base of the external gearbox and, on engines incorporating S.B.72-3727, in the tube from the L.P./I.P./H.P. compressor location bearings and internal gearbox.

The detectors (Ref. fig.2) are of the quickly removable, self-sealing type and comprise a magnetic probe positioned in a housing, the two items being locked together by a bayonet type connector. The housing is secured to the engine with a two-bolt mounting.

To provide a visual locking check, a hole in the probe end face aligns with a hole in the detector housing when the assembly is correctly locked.

F. Fine Scavenge Filter

The filter is located on the left-hand side of the L.P. compressor case in zones 412, 422 and 432. It is positioned downstream of the scavenge pumps and arrests any debris carried by the return oil thus minimizing contamination of the oil cooling system units.

The filter basically comprises an element in a cylindrical case. The case accommodates inlet and outlet connectors, mounting bosses, a by-pass valve and a drain plug. The element is of metal construction and for checking and cleaning purposes can be withdrawn from the top of the filter case. The by-pass valve operates when the pressure drop across the filter exceeds a pre-determined maximum. On engines incorporating S.B.71-2608, a pressure differential switch is fitted to the filter to provide flight station indication of approaching filter restriction.

3. Operation

A. Circulation - Feed oil

Oil is drawn through the tank outlet strainer (Ref. fig.7) by the pressure pump. From the pump the feed oil is sensed by the high pressure relief valve and passed through the pressure filter downstream of which are internal drillings to the anti-syphon jet, external gearbox and the metered spill jet.

The feed oil is passed to the distributor block from where it is fed, through individual tubes, to supply lubrication for the external gearbox drive and housing, lubrication and squeeze film damping for the roller bearings and lubrication for ball bearings and internal gearbox bevel gears.

B. Circulation - Return oil

Oil from the engine main bearing chambers is returned through individual tubes to the main scavenge pumps. On engines incorporating S.B.72-3727, a magnetic chip detector is positioned in the tube from the L.P./I.P./H.P. compressor location bearings and internal gearbox.

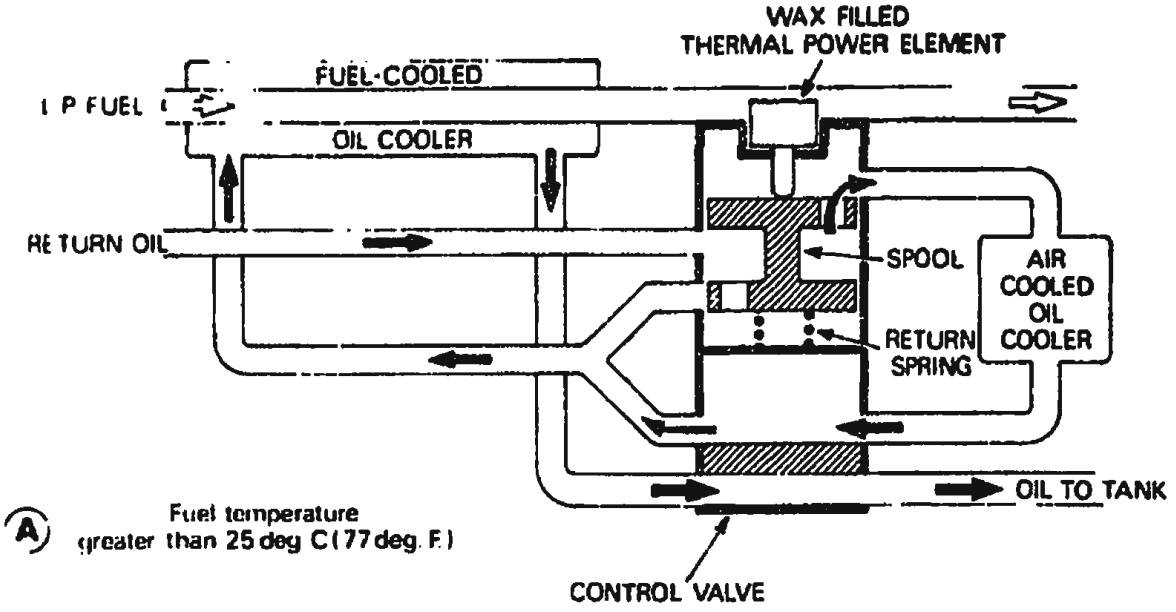
Oil from the external gearbox drive and housing flows down the annular space between the driveshaft and shroud to the external gearbox. Oil is drawn from the gearbox by a separate scavenge pump, through a tube containing a magnetic chip detector and gauze strainer, to join the return oil flow from the main scavenge pumps. This combined return oil flow is sampled by a master magnetic chip detector and passed through the fine scavenge filter before entering the oil coolers. After cooling, the oil is returned to the oil tank where it is discharged over the de-aerator tray prior to re-circulation.

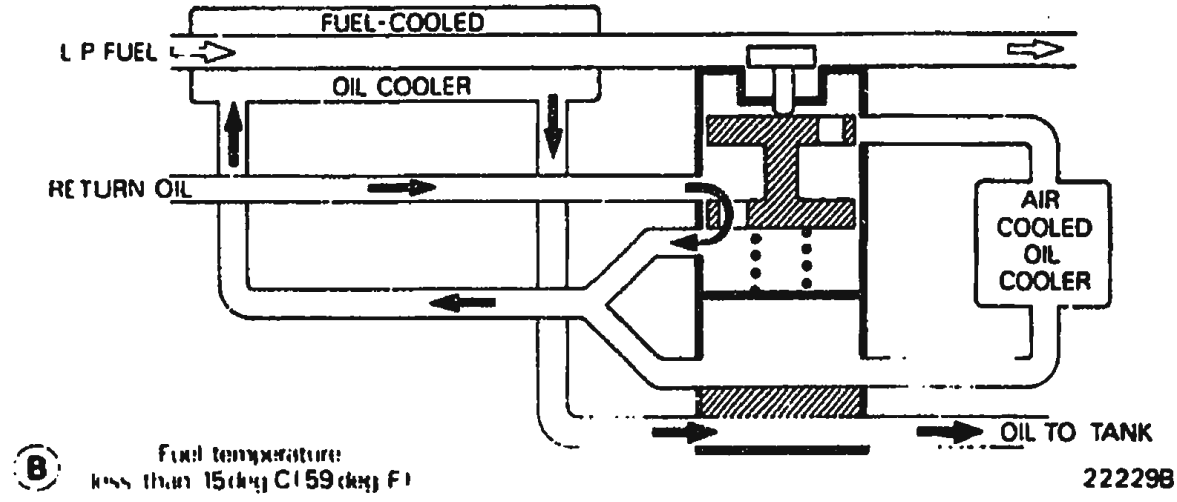
On engines with S.B.72-4689 the scavenge oil return lines from the internal gearbox and the L.P. turbine bearing are transposed at the inlet to the scavenge pumps ref. fig.2A. This effectively increases the L.P. turbine bearing scavenging capacity, ref. Fig.7A, thus reducing the possibility of oil loss should a fine scavenge filter blockage occur.

C. Air Venting

Each engine main bearing chamber is vented, through restrictors housed in external tubes, into a collector block and then via the annular space between the external gearbox driveshaft and shroud into the external gearbox. However, on engines incorporating S.B.72-2493, the front section of the L.P. turbine bearing oil vent tube is removed and appropriate blanks fitted. On engines incorporating S.B.72-2919, the rear section of the L.P. turbine bearing oil vent tube is also removed and an appropriate blank fitted.

The air/oil mist released from the oil tank de-aerator tray also passes into the external gearbox which is vented by a centrifugal breather (Ref. fig.5) to atmosphere.




Oil cooling system operation
Fig.6

D. Return Oil Cooling

With the thermal power element fully extended (Ref. A, fig.6), the spool is positioned against its return spring and all the uncooled engine return oil is directed through the air-cooled oil cooler and then the fuel-cooled oil cooler to provide maximum oil cooling.

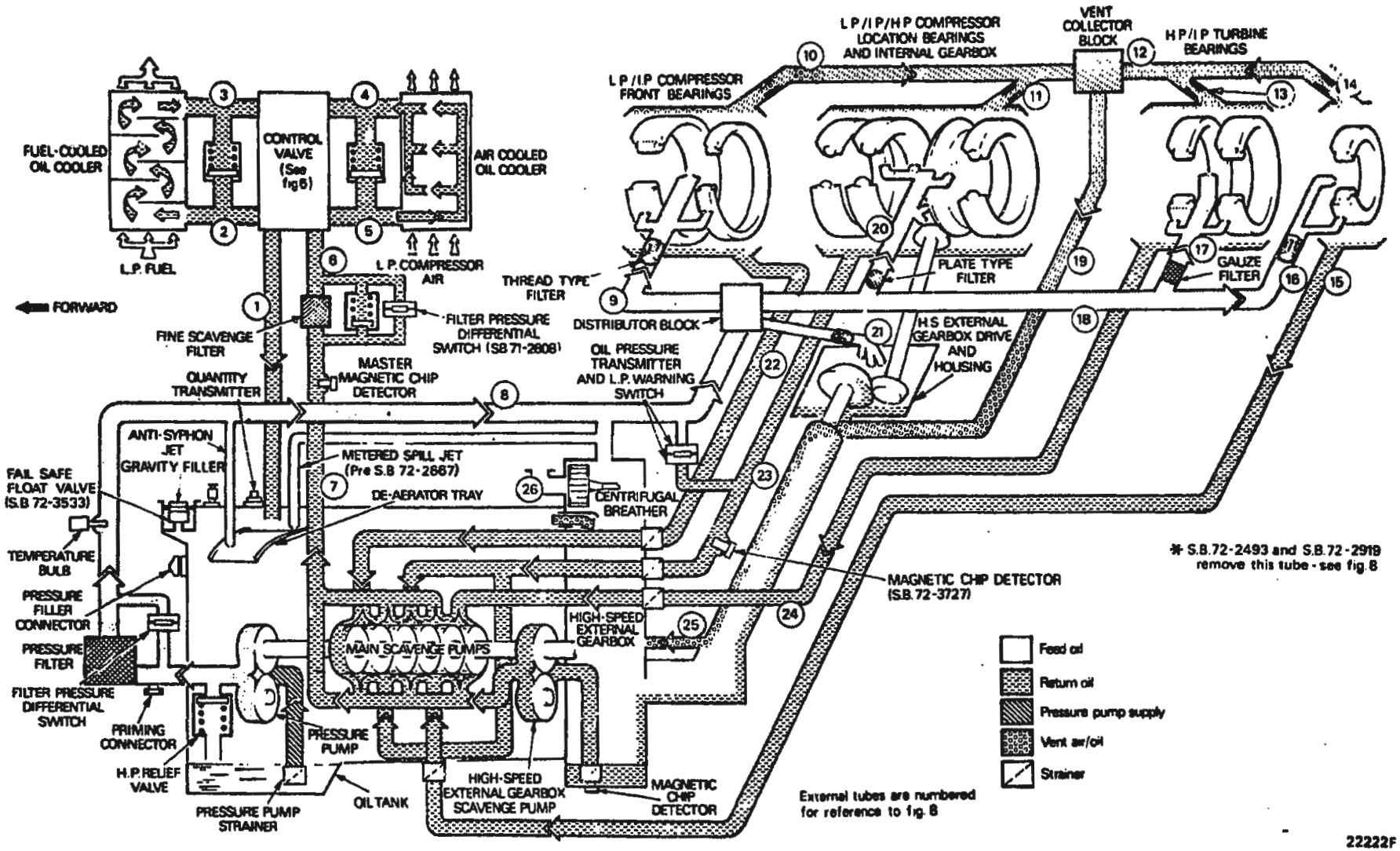
The thermal power element will begin to contract should the fuel temperature fall below 25 deg.C. (77 deg.F.). This allows return spring pressure to move the spool and progressively open the outlet to the fuel-cooled oil cooler simultaneously closing the outlet to the air-cooled oil cooler. This action allows a proportion of the uncooled engine return oil to flow directly to the fuel-cooled oil cooler and provide fuel heating.

The thermal power element will be fully contracted when the fuel temperature falls below 15 deg.C. (59 deg.F.) and all uncooled engine return oil is directed through the fuel-cooled oil cooler (Ref. B, fig.6). In this condition the fuel-cooled oil cooler performs the dual function of fuel heating and oil cooling.

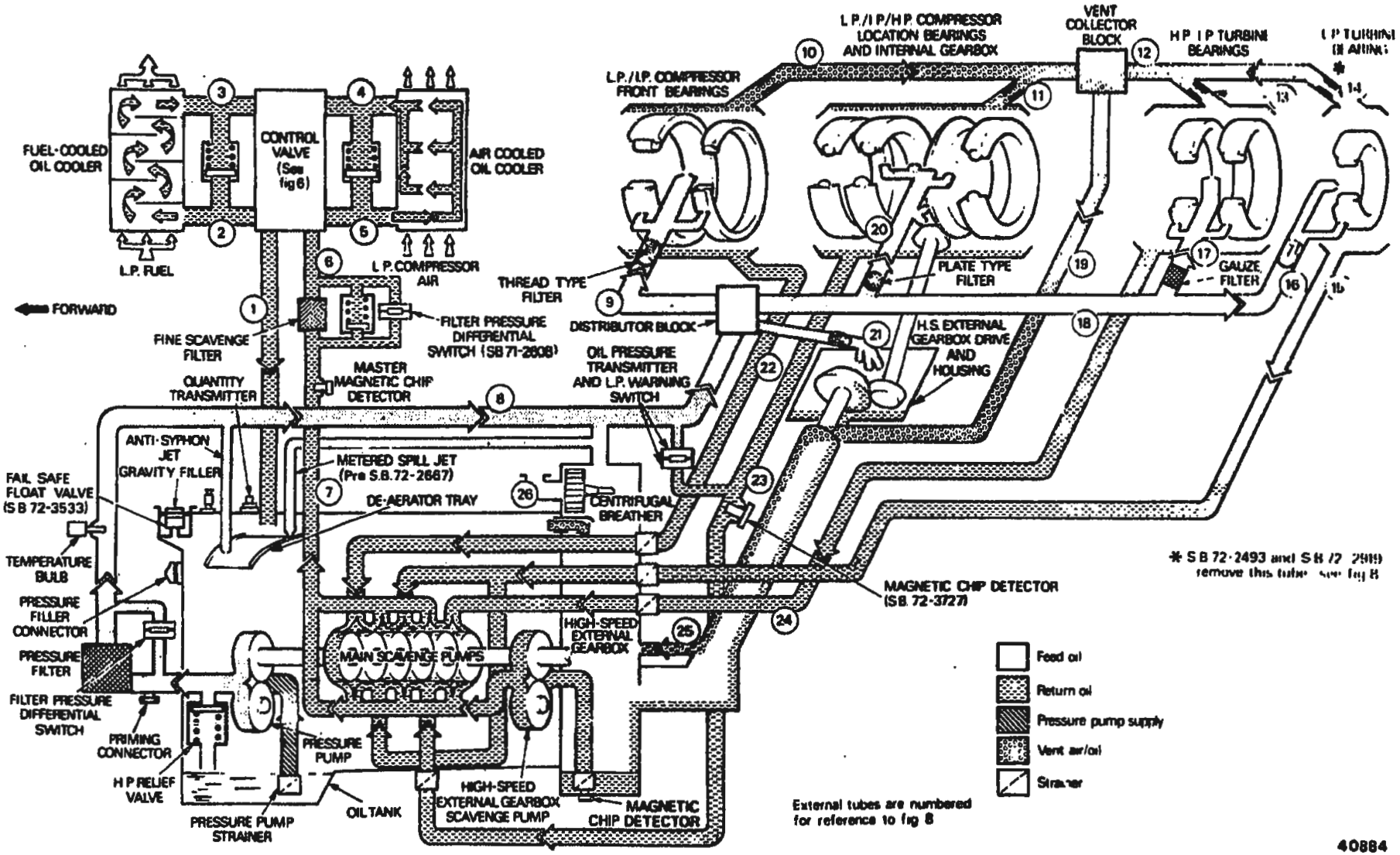
E. Indicating

Flight station indications are provided for oil pressure, temperature and oil tank quantity (indicators) and oil low pressure and pressure filter restriction (illuminated indicators). On engines incorporating S.B.71-2608, the fine scavenge filter pressure differential switch is electrically connected in parallel with the pressure filter switch to operate the same illuminated indicator.

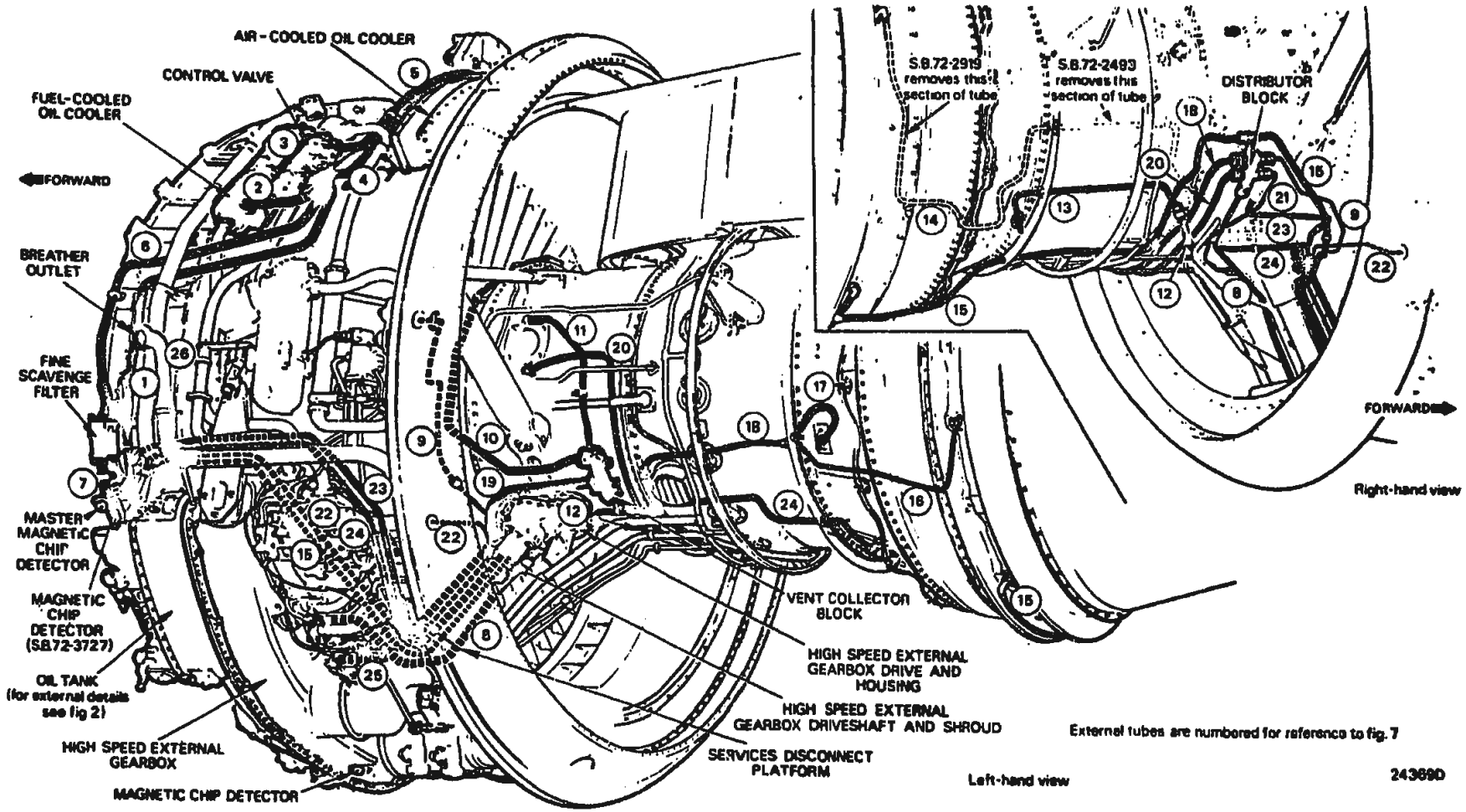
The oil pressure transmitter and oil low pressure warning switch utilize the pressure differential between engine feed and return oil. The oil filter pressure differential switch, and on engines incorporating S.B.71-2608 the fine scavenge filter pressure differential switch, sense the pressure differential between tappings taken from filter inlet and outlet. Oil temperature is sensed by a thermometer bulb positioned downstream of the pressure filter. For unit locations see fig.2. For indicating system description refer to 79-31-00.




Oil system diagram - engines without S.B.72-4689
Fig.7




Oil system diagram -
engines with S.B.72-4689
Fig.7A




Oil system external units and tubes
Fig.8

## OIL SYSTEM - SERVICING

R WARNING: 1. THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE
R MAY CAUSE IRRITATION IF SKIN CONTACT IS REPEATED OR
R PROLONGED.

2. IMMEDIATELY AFTER SHUT DOWN ENGINE OIL TEMPERATURE REMAINS HIGH, THEREFORE, EXTREME CARE MUST BE OBSERVED WHEN WORKING NEAR TO OR ON ENGINE OIL SYSTEM COMPONENTS AND TUBES.

CAUTION : 1. THE OIL SPECIFIED FOR USE IN THIS OIL SYSTEM IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS OF THE ENGINE NOT NORMALLY IN CONTACT WITH IT. ANY OIL SPILT DURING SERVICING MUST BE WIPED UP IMMEDIATELY.

2. CONTAMINATION BY MINUTE AMOUNTS OF CERTAIN ALKALINE CLEANING FLUIDS CAN CAUSE COMPLETE BREAKDOWN OF THE SYNTHETIC OIL. USE SCRUPULOUSLY CLEAN CONTAINERS AND EQUIPMENT.

3. DRAINED OIL MUST NOT BE RETURNED TO THE SYSTEM.

### 1. Drain Oil System

#### A. Drain Oil Tank

(1) Equipment required:

Clean receptacle - minimum capacity

6.0 U.S. gallons
5.0 Imperial gallons
23.0 Litres

(2) Open left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00, Servicing) or 433AL for engine No.2 (Ref. 71-12-01, Servicing).

(3) Refer to fig.301, position receptacle, remove bolt and washer from oil drain cover and allow oil to drain.

(4) Fit and secure bolt and washer to oil drain cover.

(5) Close left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00, Servicing) or 433AL for engine No.2 (Ref. 71-12-01, Servicing).

B. Drain High-speed External Gearbox

(1) Remove magnetic chip detector assembly (Ref. 72-01-00, Removal/Installation) and allow oil to drain.

(2) Fit and secure magnetic chip detector assembly (Ref. 72-01-00, Removal/Installation).

C. Drain Return Oil Tubes

(1) Remove scavenge strainer elements (Ref. 72-01-00, Removal/Installation) and allow oil to drain.

(2) Fit and secure scavenge strainer elements (Ref. 72-01-00, Removal/Installation).

D. Drain Pressure Filter

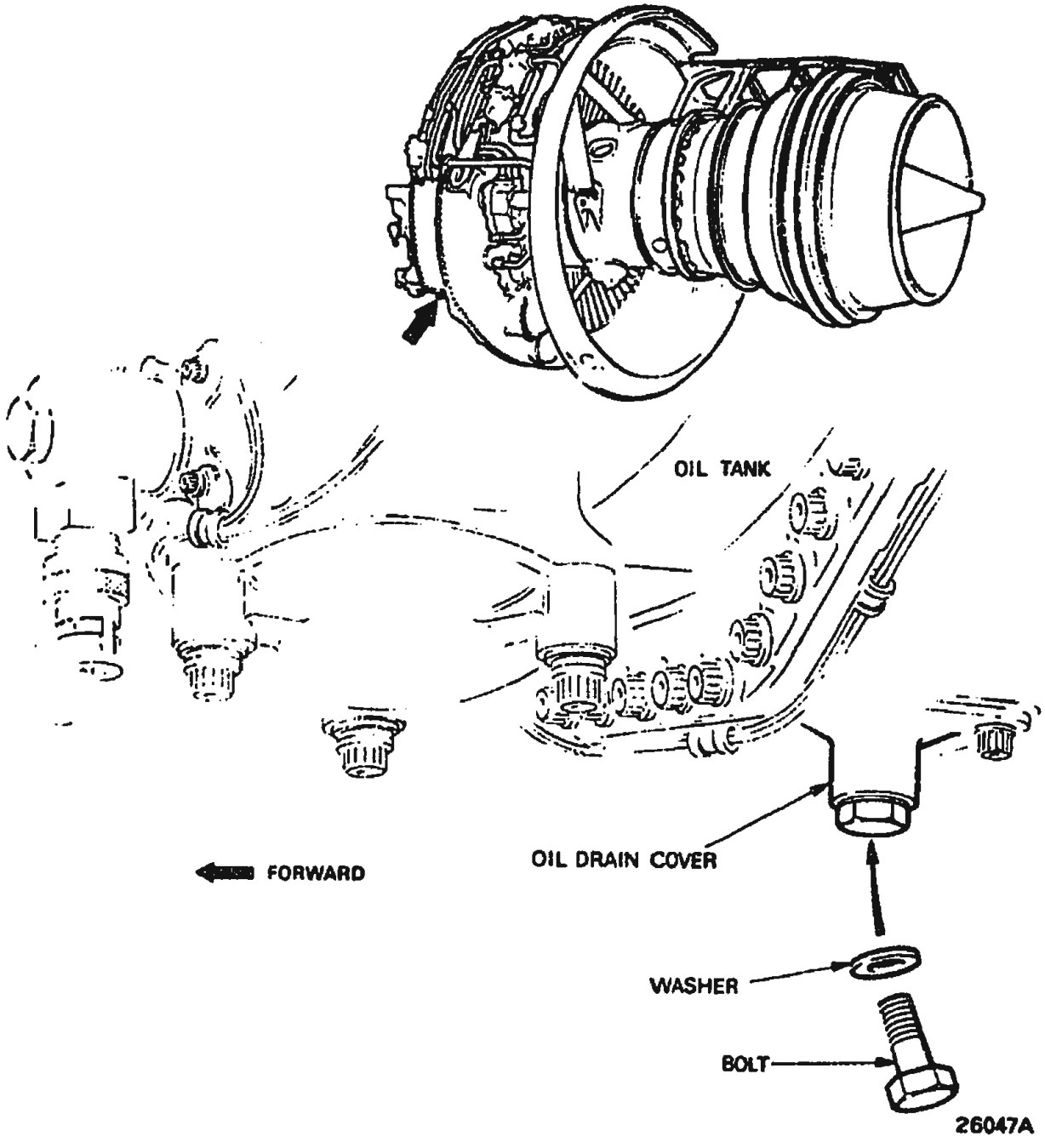
(1) Remove pressure filter end cover (Ref. 72-01-00, Removal/Installation) and allow oil to drain.

(2) Fit and secure pressure filter end cover (Ref. 72-01-00, Removal/Installation).

E. Drain Fine Scavenge Filter

(1) Remove fine scavenge filter drain plug (Ref. 72-01-00, Removal/Installation) and allow oil to drain.

(2) Fit and secure fine scavenge filter drain plug (Ref. 72-01-00, Removal/Installation).




Oil tank drain point
Fig.301

## OIL SYSTEM - REMOVAL/INSTALLATION

**WARNING:** 1. THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE MAY CAUSE SKIN IRRITATION IF SKIN CONTACT IS REPEATED OR PROLONGED.

2. IMMEDIATELY AFTER SHUT DOWN ENGINE OIL TEMPERATURE REMAINS HIGH, THEREFORE, EXTREME CARE MUST BE OBSERVED WHEN WORKING NEAR TO OR ON ENGINE OIL SYSTEM COMPONENTS AND TUBES.

**CAUTION:** 1. THE OIL SPECIFIED FOR USE IN THIS OIL SYSTEM IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS OF THE ENGINE NOT NORMALLY IN CONTACT WITH IT. ANY OIL SPILT DURING SERVICING MUST BE WIPED UP IMMEDIATELY.

2. CONTAMINATION BY MINUTE AMOUNTS OF CERTAIN ALKALINE CLEANING FLUIDS CAN CAUSE COMPLETE BREAKDOWN OF THE SYNTHETIC OIL. USE SCRUPULOUSLY CLEAN CONTAINERS AND EQUIPMENT.

3. DRAINED OIL MUST NOT BE RETURNED TO THE SYSTEM.

The Removal/Installation procedures described in this section are as follows.

| Paragraph | Procedure |
|---|---|
| 1 | Magnetic Chip Detector |
| 2 | Magnetic Chip Detector Housing |
| 3 | Fine Scavenge Filter Element |
| 4 | Scavenge Strainer Elements |
| 5 | Pressure Filter Element |
| 6 | Pressure Pump Strainer |
| 7 | Distributor Block |

## 1. Removal/Installation Magnetic Chip Detector

NOTE: The following sequence of operations also applies if detectors are fitted at main scavenge strainer positions.

Service Bulletins referred to:

72-3727 - Internal Gearbox Oil Return Tube with Magnetic Chip Detector Fitted
72-5054 - Introduction of Vactric type VB3447 Magnetic Chip Detectors
R 72-7911 - Introduction of Magnetic Chip Detector with
R Revised Bayonet

Referenced Procedures:

| | | |
|---|---|---|
| R | 70-02-01 | Identification, Lubrication and Fitting of Rubber |
| R | | Sealing Rings |
| R | 71-00-00 | Power Plant - Adjustment/Test |
| | 71-11-00 | Cowling, Engines No.1 and No.3 - Servicing |
| | 71-12-01 | L.H. and R.H. Lower Hinged Cowl - Servicing |
| R | 72-01-00 | Oil System - Inspection/Check |

Illustrated Parts Catalogue References:

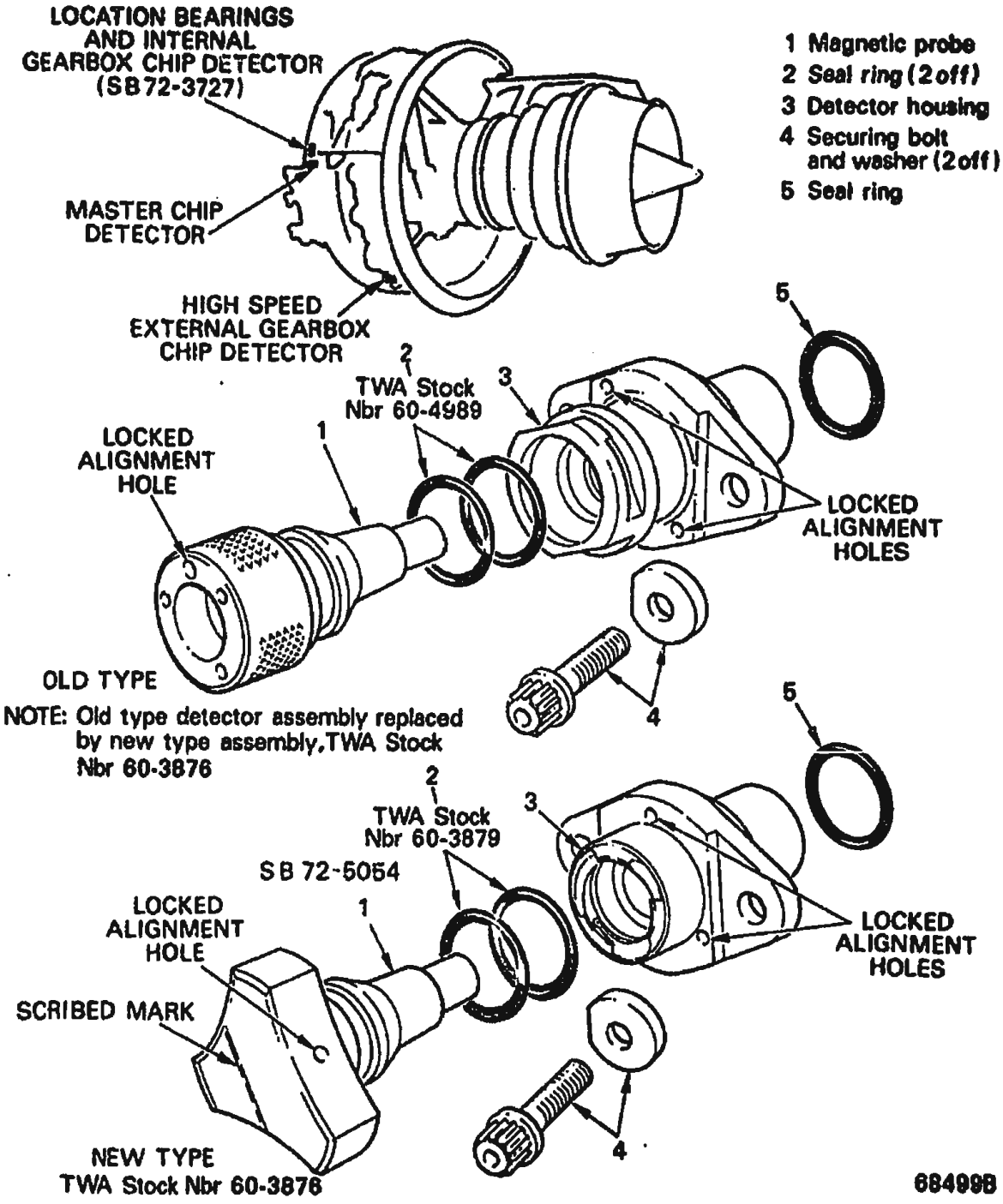
The I.P.C. sections where parts disturbed during the following operations can be located are as follows:

| | |
|---|---|
| 72-01-01 | Oil System Tubes and Fittings |
| 72-63-00 | H.S. External Gearbox |

A. Remove Magnetic Chip Detector

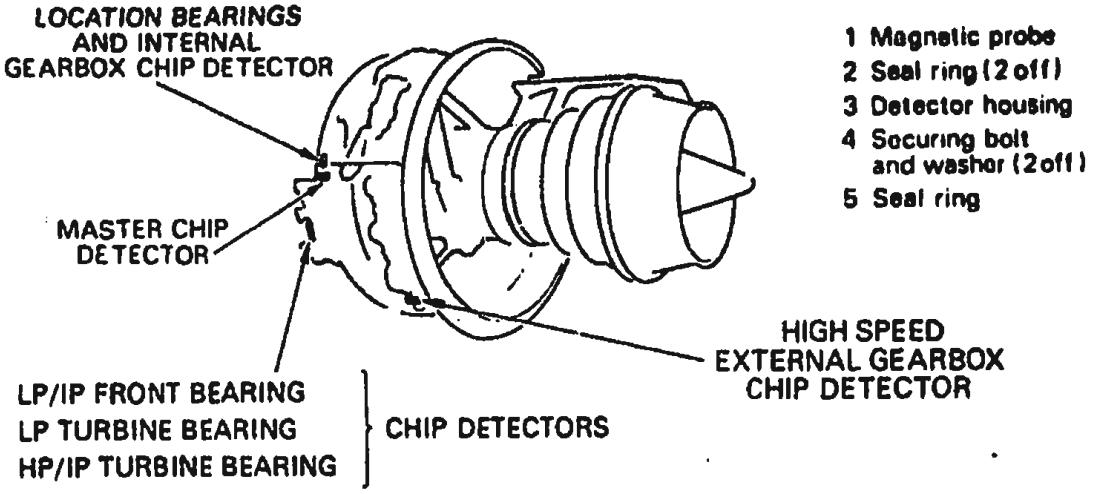
(1) For master chip detector, and on engines incorporating S.B.72-3727, the compressor location bearings and internal gearbox return oil chip detector, open oil filler access door 413B or 423B for engines No.1 and 3 or 433BL for engine No.2.

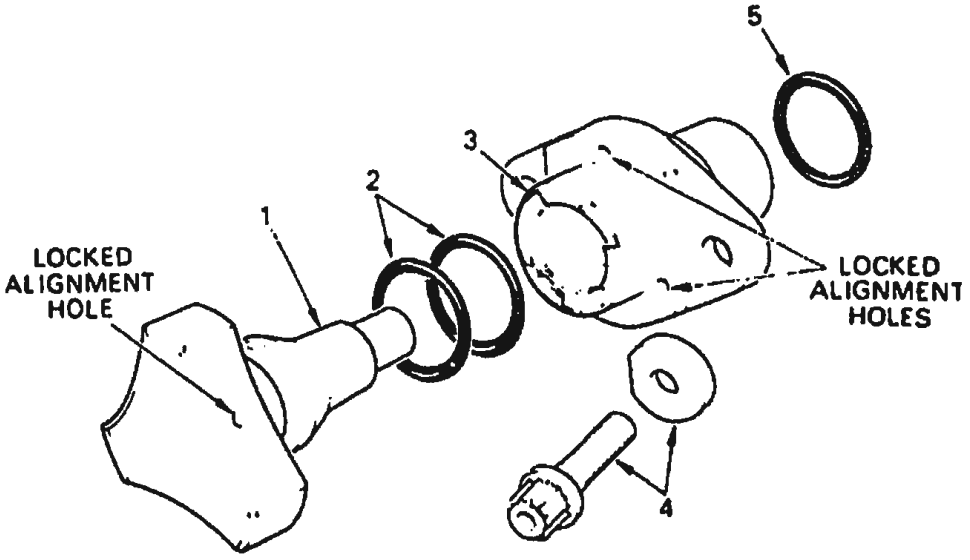
For high-speed external gearbox chip detector and main scavenge strainer chip detectors, open left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).




CR Magnetic chip detector assembly - Removal/Installation
CR Engines without S.B.72-7911
CR Fig.401 (Sheet 1)

EFFECTIVITY: ALL


LOCATION BEARINGS AND INTERNAL GEARBOX CHIP DETECTOR
MASTER CHIP DETECTOR
LP/IP FRONT BEARING
LP TURBINE BEARING
HP/IP TURBINE BEARING
CHIP DETECTORS
HIGH SPEED EXTERNAL GEARBOX CHIP DETECTOR
1 Magnetic probe
2 Seal ring (2 off)
3 Detector housing
4 Securing bolt and washer (2 off)
5 Seal ring




83587

R Magnetic chip detector assembly - Removal/Installation
R Engines with S.B.72-7911
R Fig.401 (Sheet 2)

(2) Engines without S.B.72-5054 and 72-7911 refer to fig.401 (Sheet 1), depress probe (1), rotate anti-clockwise through 90 degrees and withdraw from housing (3).

(3) Engines with S.B.72-7911, refer to fig.401 (Sheet 2), depress probe (1) and rotate anti-clockwise to release bayonet lock then withdraw from housing (3).

NOTE: Upon removal, probes should be functionally identified and retained for inspection (Ref. 72-01-00).

B. Prepare for Installation

(1) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Clean kerosine | | | |

(2) Refer to fig.401, rinse probe (1) in kerosine and wipe clean.

(3) Check security of M.C.D. bayonet pins.

On engines incorporating S.B.72-5054 or 72-7911, use finger pressure to ensure that bayonet pins cannot be pushed into or withdrawn from probe body. If any
R of the three bayonet pins are found to be loose or show
R visible signs of wear, reject probe.

(4) Lubricate and fit seal rings (2).

CAUTION: 1. FAILURE TO INSTALL SEAL RINGS CAN RESULT IN EXCESSIVE OIL LOSS DURING ENGINE OPERATION CAUSING POSSIBLE ENGINE FAILURE.

2. FAILURE TO LUBRICATE EXPOSED SURFACES OF SEAL RINGS CAN RESULT IN SEAL DAMAGE DURING PROBE INSTALLATION RESULTING IN EXCESSIVE OIL LOSS DURING ENGINE OPERATION CAUSING POSSIBLE ENGINE FAILURE.

R (a) If seal rings appear flattened, twisted, damaged or
R swollen, or if oil leakage was apparent at detector removal, remove seal rings and fit new seal rings (Ref.70-02-01) lubricated with engine oil.

(b) If seal rings are satisfactory, lubricate exposed faces of rings with engine oil.

C. Install Magnetic Chip Detector

CAUTION: INSTALLATION OF MAGNETIC CHIP DETECTOR WITHOUT SEAL RINGS CAN RESULT IN EXCESSIVE OIL LOSS DURING ENGINE OPERATION CAUSING POSSIBLE ENGINE FAILURE.

(1) Refer to fig.401. ensure seal rings (2) are fitted to probe (1) and have been lubricated with engine oil.

(2) Engines without S.B.72-5054 and 72-7911 carefully enter probe (1) into housing (3) aligning lugs with flats on housing; depress probe fully and rotate clockwise through 90 degrees until it cannot be rotated any. further clockwise. Pull probe outwards to engage bayonet lock and ensure it will not turn anti-clockwise. Check that locked holes in probe end face and housing are aligned.

(3) Engines with S.B.72-5054, carefully enter probe (1) into housing (3) aligning bayonet pins with slots in housing. Depress probe fully and rotate clockwise until positive engagement is apparent and probe cannot be rotated any further (approximately 60 degrees). Pull probe outwards to engage bayonet lock and ensure it cannot be turned anti-clockwise.

(4) Engines with S.B.72-7911, carefully enter probe (1) into housing (3) aligning pins on probe with slots in housing; depress probe fully and rotate clockwise until no further rotation is possible and release probe. Check for positive engagement by attempting to rotate the probe in either direction whilst pulling lightly. The probe must remain engaged and no rotation should be evident. Check that locked holes in probe end face and housing are aligned.

NOTE: On engines with S.B.72-7911 if probe is inserted with forward seal ring missing a baulking feature will prevent engagement.

(5) For master chip detector, and on engines incorporating S.B.72-3727, the compressor location bearings and internal gearbox chip detector, close oil filler access door 413B or 423B for engines No.1 and 3 or 433BL for engine No.2.

For high-speed external gearbox chip detector and main scavenge strainer chip detectors, close left-hand hinged cowl 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

CR (6) Unless fleet accomplishment of Rolls-Royce
CR S.B.RB211-72-7911 has been incorporated, perform
CR Oil Leak Test No.5 (Ref. 71-00-00).

## 2. Removal/Installation Magnetic Chip Detector Housing

NOTE: The following sequence of operations also applies if detectors are fitted at main scavenge strainer positions.

Service Bulletins referred to:

72-3727 - Internal Gearbox Oil Return Tube with Magnetic Chip Detector Fitted
72-5054 - Introduction of Vactric type VB3447 Magnetic Chip Detectors
R 72-7911 - Introduction of Magnetic Chip Detector with Revised
R Bayonet

Referenced Procedures:

| | | |
|---|---|---|
| | 12-12-01 | Engine Oil Replenishment |
| | 70-02-01 | Identification, Lubrication and Fitting of Rubber Sealing Rings |
| | 70-51-00 | Torque Tightening Technique |
| R | 71-00-00 | Power Plant - Adjustment/Test |
| | 71-11-00 | Cowlings, Engines No.1 and No.3 - Servicing |
| | 71-12-01 | L.H. and R.H. Lower Hinged Cowl - Servicing |

Illustrated Parts Catalogue References:

The I.P.C. sections where parts disturbed during the following operations can be located are as follows:

| | |
|---|---|
| 72-01-00 | Oil System Tubes and Fittings |
| 72-63-00 | H.S. External Gearbox |

A. Remove Magnetic Chip Detector Housing

(1) Equipment required:

Clean receptacle - minimum capacity

14.0 U.S. pints
12.0 Imperial pints
9.0 Litres

(2) For master chip detector, and on engines incorporating S.B.72-3727, the compressor location bearings and internal gearbox chip detector, open left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or access panel 433BL for engine No.2.

For high-speed external gearbox chip detector and main scavenge strainer chip detectors, open left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

(3) Refer to fig.401, remove probe (1) (Ref. para.1.A.).

(4) Remove bolts and washers (4).

(5) Withdraw housing (3) and allow oil to drain into receptacle.

B. Prepare for Installation

(1) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid | | | |
| Methylethylketone (M.E.K.) | B.S.1940 1968 | - | 135 |
| or | | | |
| Acetone | B.S.509: 1964 | - | 150 |
| or | | | |
| Methylene Chloride (Dichloromethane) | B.S.1994: 1953 | - | 169 |
| Clean kerosine | | | |

(2) Refer to fig.401, wash housing (3) in clean kerosine and wipe clean.

(3) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.

CAUTION: CARE MUST BE TAKEN WHEN APPLYING THE SOLVENT AS THE SURFACE PROTECTION WILL BE AFFECTED. ANY AFFECTED AREAS MUST BE REPROTECTED IN ACCORDANCE WITH 70-42-12, LOCAL SURFACE PROTECTION.

Using degreasing fluid, clean mating faces of detector housing and oil tank and allow to dry.

NOTE: Operation (3) does not apply to master chip detector housing and on engines incorporating S.B.72-3727, the compressor location bearings and internal gearbox chip detector housing.

(4) CAUTION: FAILURE TO INSTALL SEAL RING CAN RESULT IN EXCESSIVE OIL LOSS DURING ENGINE OPERATION CAUSING POSSIBLE ENGINE FAILURE.

Fit and lubricate (Ref. 70-02-01) new seal ring (5) to housing (3).

C. Install Magnetic Chip Detector Housing

(1) Equipment required:

Clean, stiff-bristled brush

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Jointing compound | DTD.900/4586 (Hylomar light) PL.32 | - | 4/46 |

(3) CAUTION: ENSURE JOINTING COMPOUND DOES NOT ENTER OIL PASSAGES.

R Brush apply a thin film of jointing compound to mating faces of detector housing and oil tank; allow compound to dry for a minimum period of 10 minutes.

NOTE: Operation (3) does not apply to master chip detector housing and on engines incorporating S.B.72-3727, the compressor location bearings and internal gearbox chip detector housing.

(4) CAUTION: INSTALLATION OF DETECTOR HOUSING WITHOUT A SEAL RING CAN RESULT IN EXCESSIVE OIL LOSS DURING ENGINE OPERATION CAUSING POSSIBLE ENGINE FAILURE.

Refer to fig.401, ensure seal ring (5) is fitted to detector housing (3) then position housing in aperture ensuring it is correctly aligned with offset bolt hole.

(5) Secure housing with bolts and washers (4) (Ref.70-51-00).

(6) Fit probe (1) (Ref. para.1.C.).

(7) Replenish oil system (Ref. 12-12-01).

(8) For master chip detector, and on engines incorporating S.B.72-3727, the compressor location bearings and internal gearbox chip detector housing, close left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or access panel 433BL for engine No.2.

For high-speed external gearbox chip detector and main scavenge strainer chip detectors, close left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref.71-12-01).

C (9) Perform Oil Leak Test No.5 (Ref.71-00-00).

## 3. Removal/Installation Fine Scavenge Filter Element

Service Bulletins referred to:

72-4889 - Increased capacity fine scavenge filter element.
72-6891 - Fine scavenge filter element with removable dirt trap.

Referenced Procedures:

| | |
|---|---|
| 12-12-01 | Engine Oil Replenishment |
| 70-02-01 | Identification, Lubrication and Fitting of Rubber Sealing Rings |
| 71-00-00 | Power Plant - Adjustment/Test |
| 71-11-00 | Cowlings, Engines No.1 and No.3 - Servicing |
| 71-12-01 | L.H. and R.H. Lower Hinged Cowl - Servicing |
| 72-01-00 | Oil System - Inspection/Check and Cleaning/Painting |

Illustrated Parts Catalogue References:

The I.P.C. section where parts disturbed during the following operations can be located is as follows:

72-01-03 Scavenge Oil Filter

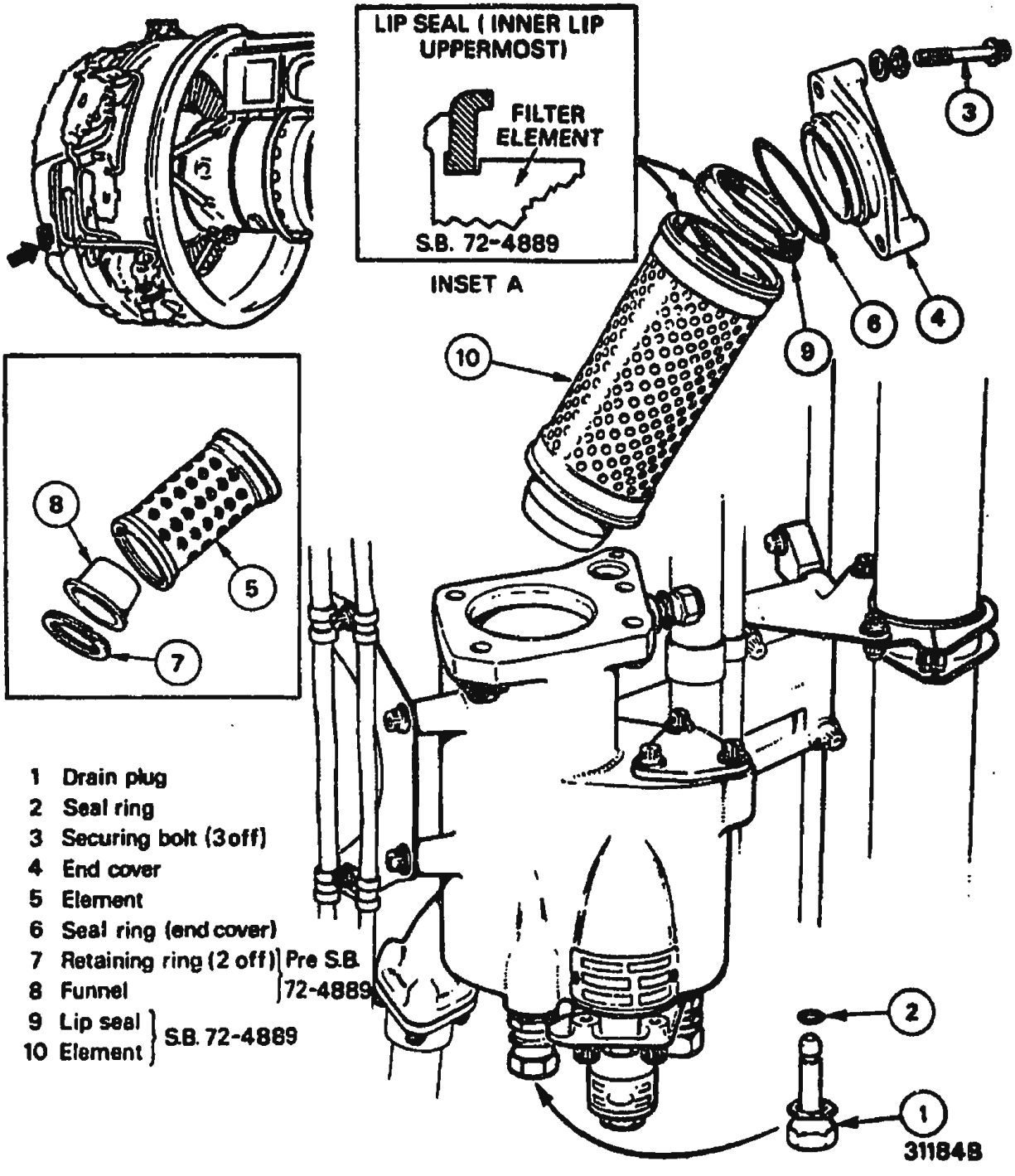
A. Remove Fine Scavenge Filter Element

(1) Equipment required:

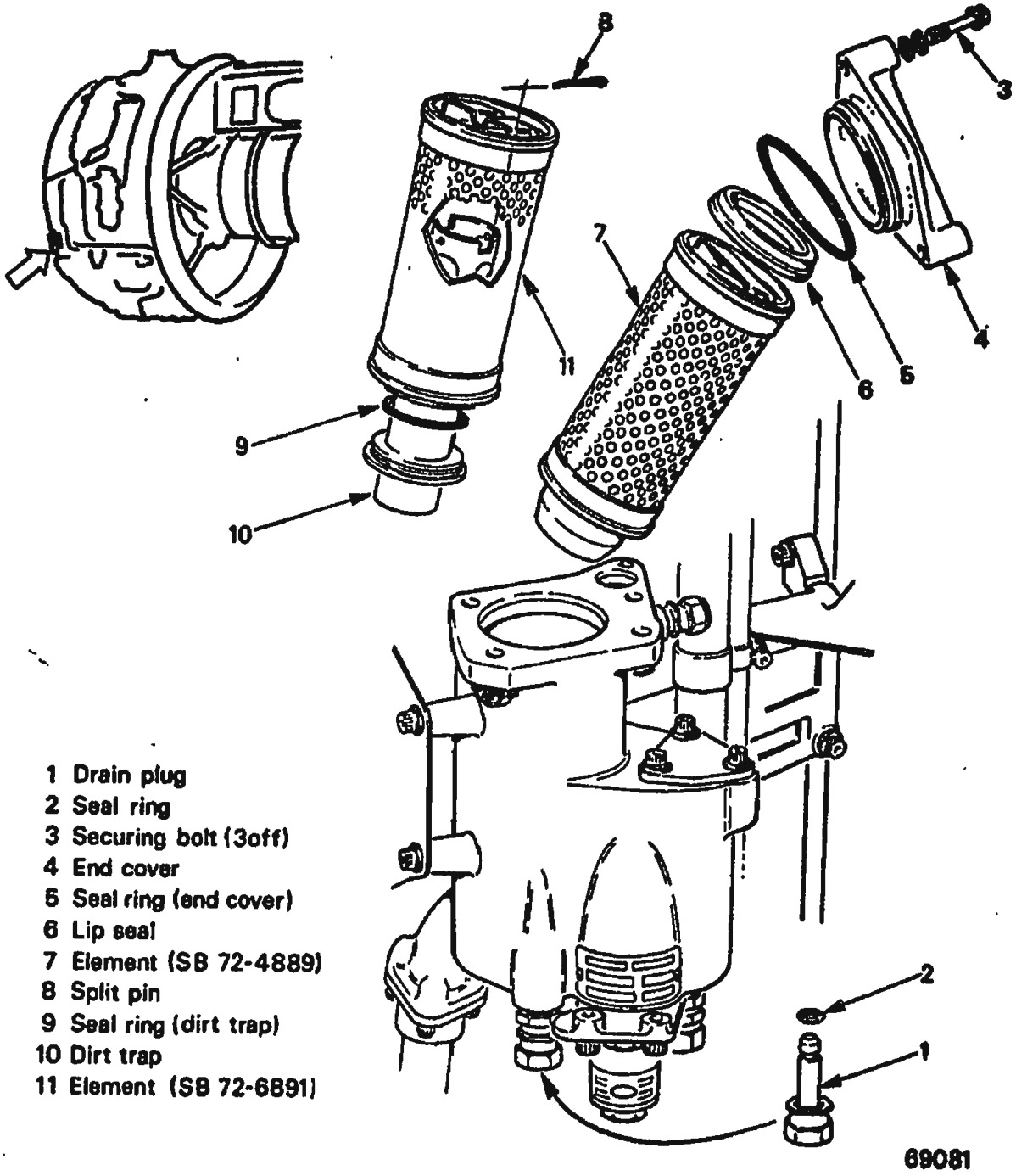
Clean receptacle - minimum capacity

10.0 U.S. pints
8.0 Imperial pints
5.0 Litres

(2) Open left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).




Fine scavenge filter element - Removal/Installation
Engines with/without S.B.72-4889, without S.B.72-6891
Fig.402 (Sheet 1)




1 Drain plug
2 Seal ring
3 Securing bolt (3off)
4 End cover
5 Seal ring (end cover)
6 Lip seal
7 Element (SB 72-4889)
8 Split pin
9 Seal ring (dirt trap)
10 Dirt trap
11 Element (SB 72-6891)

Fine scavenge filter element - Removal/Installation
Engines with S.B.72-4889 or S.B.72-6891
Fig.402 (Sheet 2)

(3) Refer to fig.402, position receptacle, remove drain plug (1) and allow oil to drain.

(4) Release bolts (3) and remove cover (4).

(5) Engines without S.B.72-4889 and S.B.72-6891

(a) Refer to fig.402 (Sheet 1), withdraw element (5) from filter housing keeping element upright to avoid losing any possible debris from funnels (8).

(b) Remove retaining rings (7) and carefully withdraw funnels from element.

(6) Engines with S.B.72-4889 without S.B.72-6891

(a) Refer to fig.402 (Sheet 1), withdraw element (10) assembly from filter housing.

(7) Engines with S.B.72-6891

(a) Refer to fig.402 (Sheet 2), withdraw element (11) from filter housing.

(b) Remove split pin (8) securing dirt trap (10) to element (11), withdraw dirt trap from element.

(8) Inspect fine scavenge filter element assembly (Ref. 72-01-00, Inspection/Check).

B. Prepare for Installation

(1) It is recommended that only filter elements which have been subject to ultrasonic cleaning procedure
R (Ref. 72-01-00) be installed.

R NOTE: In the interests of operational requirements,
R kerosine washed scavenge filters may be refitted
R to the engine provided any excess kerosine is
R shaken off. Any filter so replaced must be
R exchanged for a filter cleaned as detailed in
R 72-01-00 within 25 hours.

(2) Engines without S.B.72-4889 and S.B.72-6891

(a) Refer to fig.402 (Sheet 1), position funnels (8) in element (5) and secure with retaining rings (7).

(3) Engines with S.B.72-4889 without S.B.72-6891

(a) Refer to fig.402 (Sheet 1), fit and lubricate new lip seal (9) to element (10).

(4) Engines with S.B.72-6891

(a) Refer to fig.402 (Sheet 2), lubricate and fit (Ref.70-02-01) new seal ring (9) to dirt trap (10).

(b) Install dirt trap (10) in element (11) and secure with split pin (8).

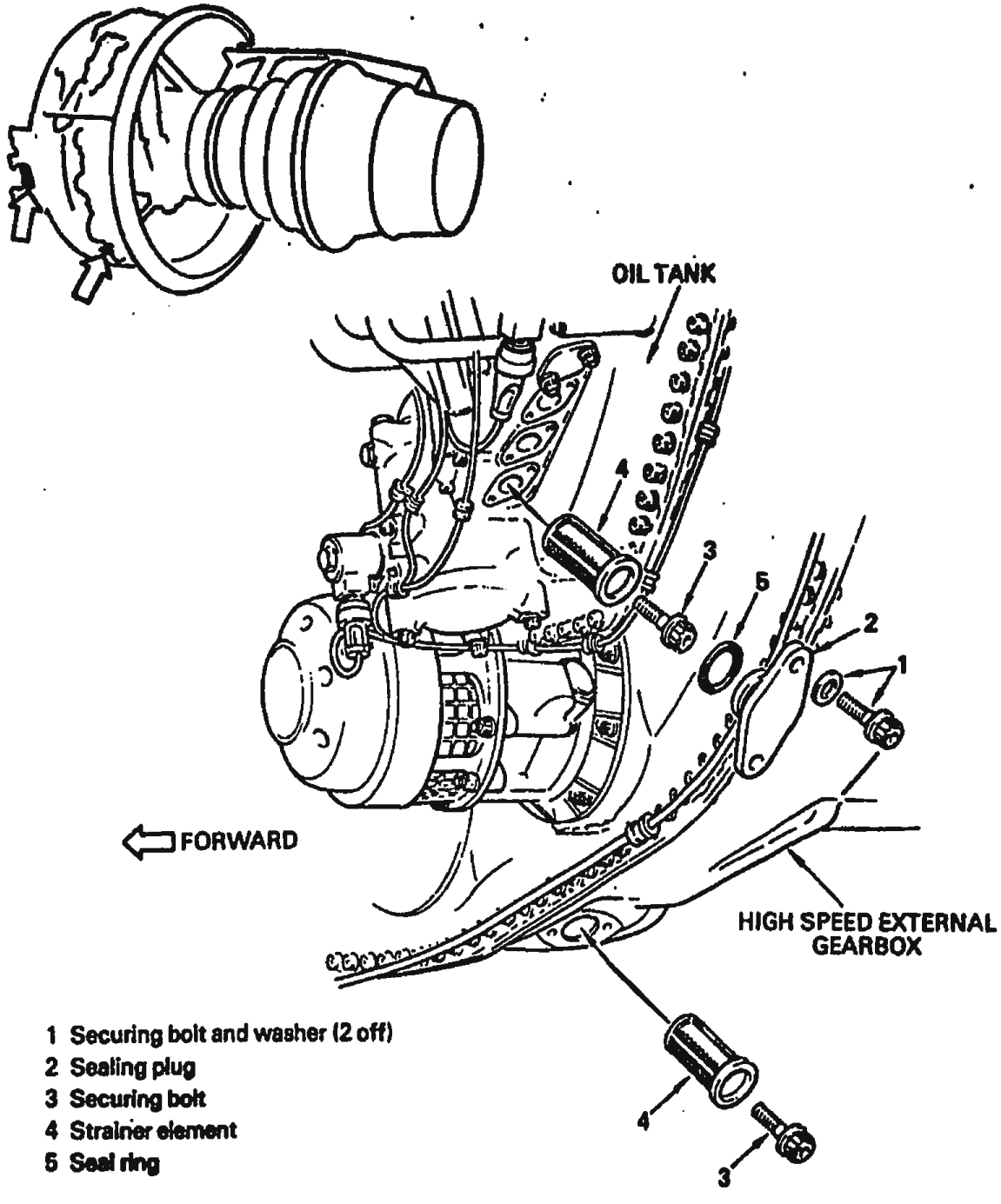
(c) Lubricate and fit new lip seal (6) to element (11).

C. Install Fine Scavenge Filter Element

(1) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Lockwire | DTD.189A 22 S.W.G. | - 21 A.W.G. | 238 |
| Clean engine oil | (Ref. 12-12-01) | | |

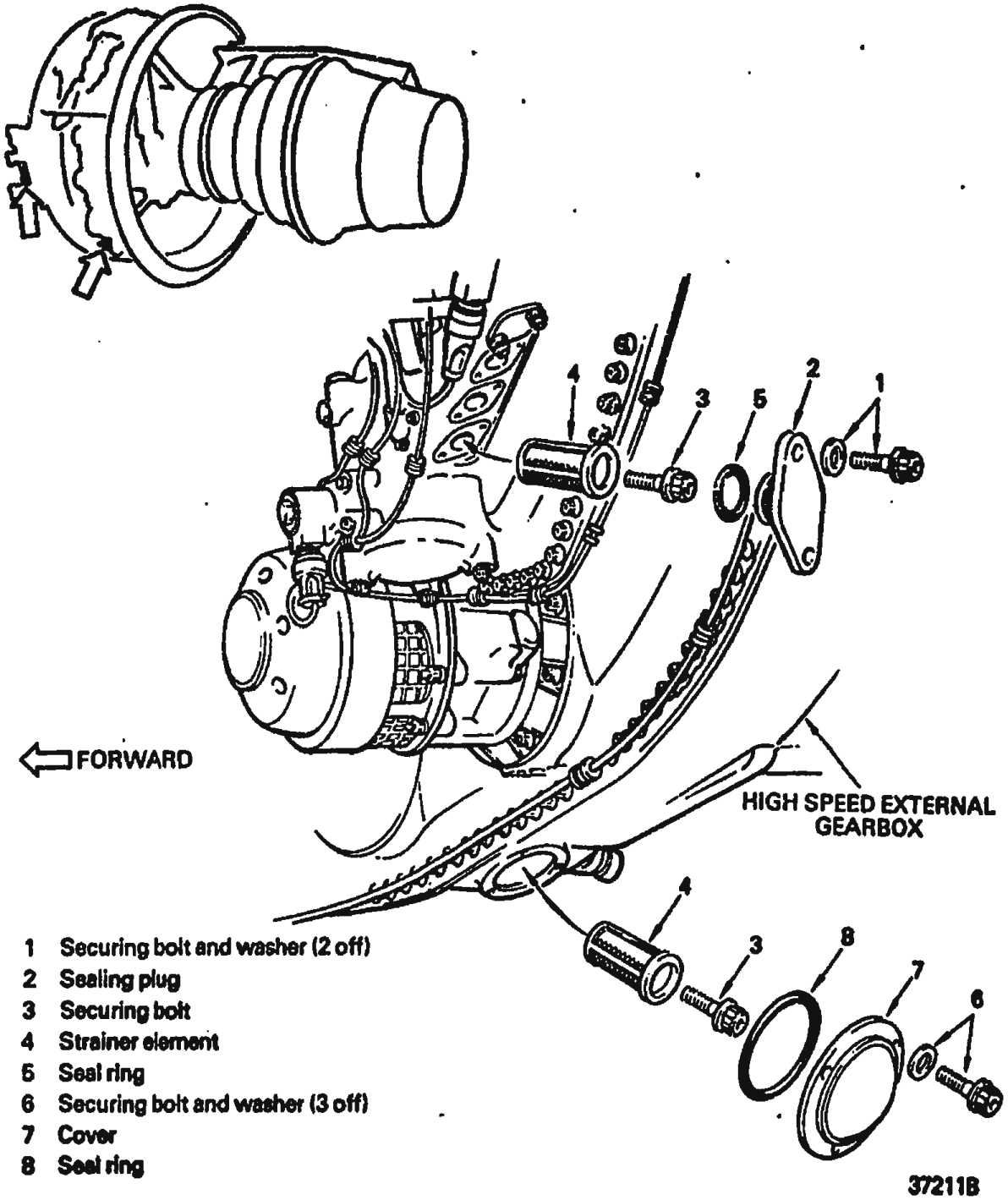
(2) Refer to fig.402, fit and lubricate (Ref. 70-02-01) new seal ring (6) to cover (4) also a new seal ring (2) to drain plug (1).




1 Securing bolt and washer (2 off)
2 Sealing plug
3 Securing bolt
4 Strainer element
5 Seal ring

25783B

Pre-S.B.72-4071 Scavenge strainer element - Removal/Installation
Fig.403 (Sheet 1)




1 Securing bolt and washer (2 off)
2 Sealing plug
3 Securing bolt
4 Strainer element
5 Seal ring
6 Securing bolt and washer (3 off)
7 Cover
8 Seal ring

S.B.72-4071 Scavenge strainer element - Removal/Installation
Fig.403 (Sheet 2)

(3) Refer to fig.402, immerse element (5)(Pre-S.B.72-4889), or (10)(S.B.72-4889) or (11)(S.B.72-6891) in clean engine oil, then position in filter housing.

(4) CAUTION: ENSURE THAT THE FILTER ELEMENT IS CORRECTLY SEATED IN BOTTOM OF FILTER HOUSING. FAILURE TO DO SO MAY RESULT IN ELEMENT BEING CRUSHED BY END COVER ON INSTALLATION.
Fit cover (4) to filter housing and secure with bolts (3).

(5) Fit and secure drain plug (1) to filter housing and wirelock.

(6) Replenish oil system (Ref. 12-12-01).

(7) Close left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

C (8) Perform Oil Leak Test No.5 (Ref. 71-00-00).

4. Removal/Installation Scavenge Strainer Elements

Service Bulletins referred to:

72-4071 - Introduction of reduced diameter scavenge inlet and bolted strainer access cover.
72-5528 - Deletion of internal gearbox scavenge strainer and strainer retention boss blanked.
72-7654 - Oil tank cover - Deletion of scavenge strainers.

Referenced Procedures:

| | |
|---|---|
| 12-12-01 | Engine Oil Replenishment |
| 70-51-00 | Torque Tightening Technique |
| 71-00-00 | Power Plant - Adjustment/Test |
| 71-11-00 | Cowlings, Engines No.1 and No.3 - Servicing |
| 71-12-01 | L.H. and R.H. Lower Hinged Cowl - Servicing |
| 72-01-00 | Oil System - Inspection/Check |

Illustrated Parts Catalogue References:

The I.P.C. section where parts disturbed during the following operations can be located is as follows:

72-63-00 H.S. External Gearbox

A. Remove Scavenge Strainer Elements

(1) Equipment required:

Clean receptacle - minimum capacity

14.0 U.S. pints
12.0 Imperial pints
9.0 Litres

(2) Open left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

NOTE: 1. The individual functions of the main scavenge strainers are identified on adjacent tank case.

2. On engines with S.B.72-5528 the internal gearbox scavenge strainer has been deleted.

R R 3. On engines with S.B.72-7654 all main scavenge pump strainers are deleted.

R 4. If chip detector assemblies are fitted at main scavenge strainer positions, refer to paragraph 2.A. for removal sequence.

(3) On engines not incorporating S.B.72-4071 refer to fig.403 (Sheet 1), release bolts and washers (1) and remove sealing plug (2), or for high-speed external gearbox strainer element remove magnetic chip detector assembly (Ref. para.2.A.); allow oil to drain into separate receptacles for examination.

On engines incorporating S.B.72-4071; refer to fig.403 (Sheet 2), release bolts and washers (1) and remove sealing plug (2), or for high-speed external gearbox strainer element, release bolts and washers (6) and remove cover (7).

(4) Remove bolt (3) and withdraw strainer element (4).

NOTE: Upon removal, strainer elements should be functionally identified and kept apart for inspection (Ref. 72-01-00).

B. Prepare for Installation

(1) Equipment required:

Compressed air supply

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid | | | |
| Methylethylketone (M.E.K.) | B.S.1940 1968 | - | 135 |
| or Acetone | B.S.509: 1964 | - | 150 |
| or Methylene Chloride (Dichloromethane) | B.S.1994: 1953 | - | 169 |

Clean kerosine

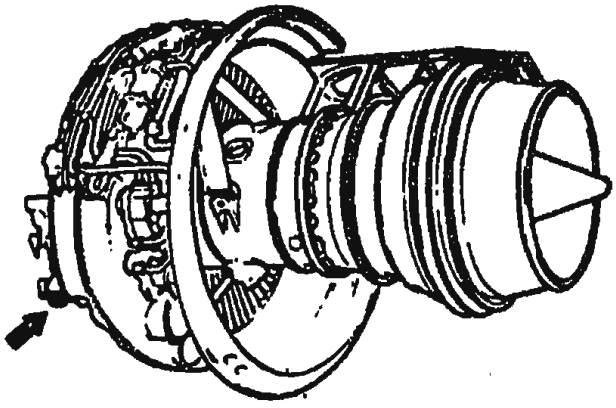
(3) Refer to fig.403, wash strainer element (4) in clean kerosine and dry with moisture free compressed air.

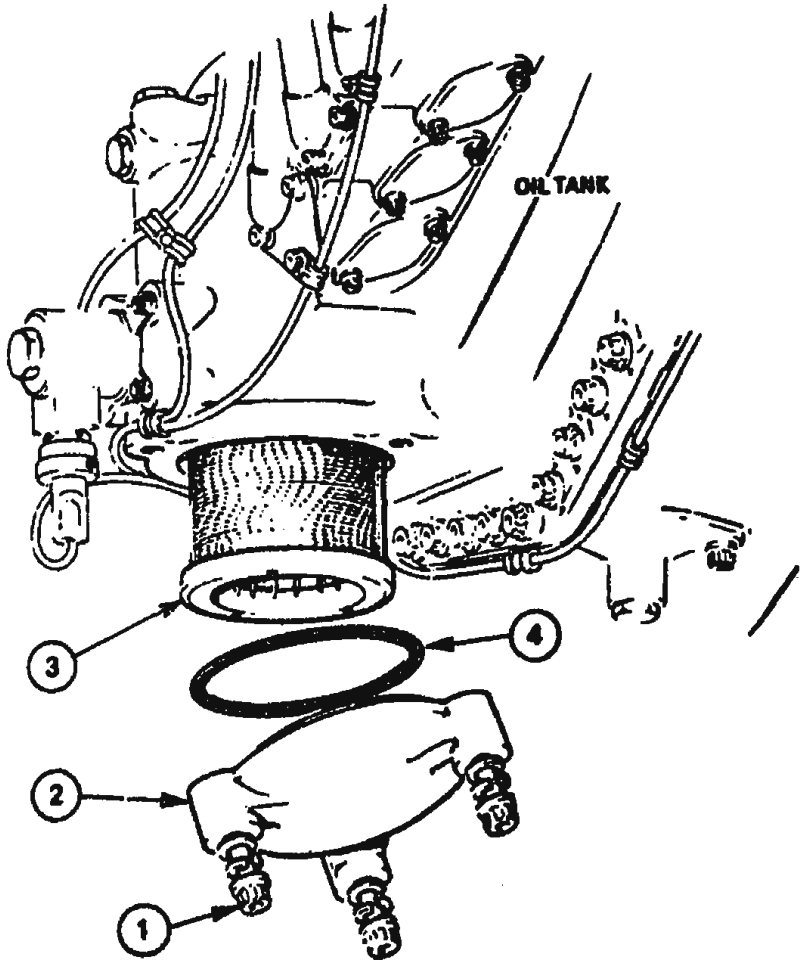
NOTE: If chip detector assemblies are fitted at main scavenge strainer positions, refer to paragraph 2.B. for preparation sequence.

(4) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.

CAUTION: CARE MUST BE TAKEN WHEN APPLYING THE SOLVENT AS THE SURFACE PROTECTION WILL BE AFFECTED. ANY AFFECTED AREAS MUST BE REPROTECTED IN ACCORDANCE WITH 70-42-12, LOCAL SURFACE PROTECTION.

Using degreasing fluid, clean mating faces of sealing plug and oil tank and allow to dry.






1. Securing bolt (3 off)
2. End cover
3. Filter element
4. Seal ring

25784

Pressure filter element - Removal/Installation
Fig.404

R (5) On engines not incorporating S.B.72-4071; refer to
R fig.403 (Sheet 1), fit and lubricate (Ref.70-02-01) new seal ring (5) to sealing plug (2); for high-speed external gearbox strainer element fit new seal ring to magnetic chip detector housing (Ref. para.2.B.).

On engines incorporating S.B.72-4071; refer to
R fig.403 (Sheet 2), fit and lubricate (Ref.70-02-01) new seal ring (5) to sealing plug (2); for high-speed external gearbox strainer element, fit new seal ring (8) to cover (7).

C. Install Scavenge Strainer Elements

(1) Equipment required:

Clean, stiff-bristled brush

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Jointing compound | DTD.900/4586 (Hylomar light) PL.32 | - | 4/46 |
| Clean engine oil | (Ref. 12-12-01) | | |

(3) CAUTION: ENSURE JOINTING COMPOUND DOES NOT ENTER OIL PASSAGES.
Brush apply a thin film of jointing compound to mating faces of sealing plug and oil tank; allow compound to dry for a minimum period of 10 minutes.

(4) Refer to fig.403, immerse strainer element (4) in clean engine oil then position in chamber and secure with bolt (3).

NOTE: If chip detector assemblies are fitted at main scavenge strainer positions, refer to paragraph 2.C. for installation sequence.

(5) On engines not incorporating S.B.72-4071; refer to fig.403 (Sheet 1), position sealing plug (2) over chamber aperture ensuring it is correctly aligned with offset bolt hole and secure with bolts (1) (Ref.70-51-00), for high-speed external gearbox strainer element refit magnetic chip detector assembly (Ref. para.2.C.).

On engines incorporating S.B.72-4071; refer to fig.403 (Sheet 2), position sealing plug (2) over chamber aperture ensuring it is correctly aligned with offset bolt hole and secure with bolts (1) (Ref.70-51-00), for high speed external gearbox strainer element, refit cover (7) and secure with bolts and washers (6).

(6) Replenish oil system (Ref. 12-12-01).

(7) Close left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

. C (8) Perform Oil Leak Test No.5 (Ref.71-00-00).

5. Removal/Installation Pressure Filter Element

Service Bulletins Referred to:

| | |
|---|---|
| 72-4557 | H.P. Oil Filter with Finer Filtration |
| 72-7166 | Introduction of Low Cost Filter |

Referenced Procedures:

| | |
|---|---|
| 12-12-01 | Engine Oil Replenishment |
| 70-02-01 | Identification, Lubrication and Fitting of Rubber Sealing Rings |
| 71-00-00 | Power Plant - Adjustment/Test |
| 71-11-00 | Cowlings, Engines No.1 and No.3 - Servicing |
| 71-12-01 | L.H. and R.H. Lower Hinged Cowl - Servicing |
| 72-01-00 | Oil System - Inspection/Check and Cleaning/ Painting |

Illustrated Parts Catalogue References:

The I.P.C. section where parts disturbed during the following operations can be located is as follows:

| | |
|---|---|
| 72-63-00 | H.S. External Gearbox |

A. Remove Pressure Filter Element

(1) Equipment required:

Clean receptacle - minimum capacity

4.0 U.S. pints
3.0 Imperial pints
2.0 Litres

(2) Open left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

(3) Refer to fig.404, slacken bolts (1) and allow oil to drain into receptacle.

(4) Release bolts (1) and remove end cover (2) and filter element (3) from housing.

(5) Inspect pressure filter element (Ref. 72-01-00 Inspection/Check).

B. Prepare for Installation

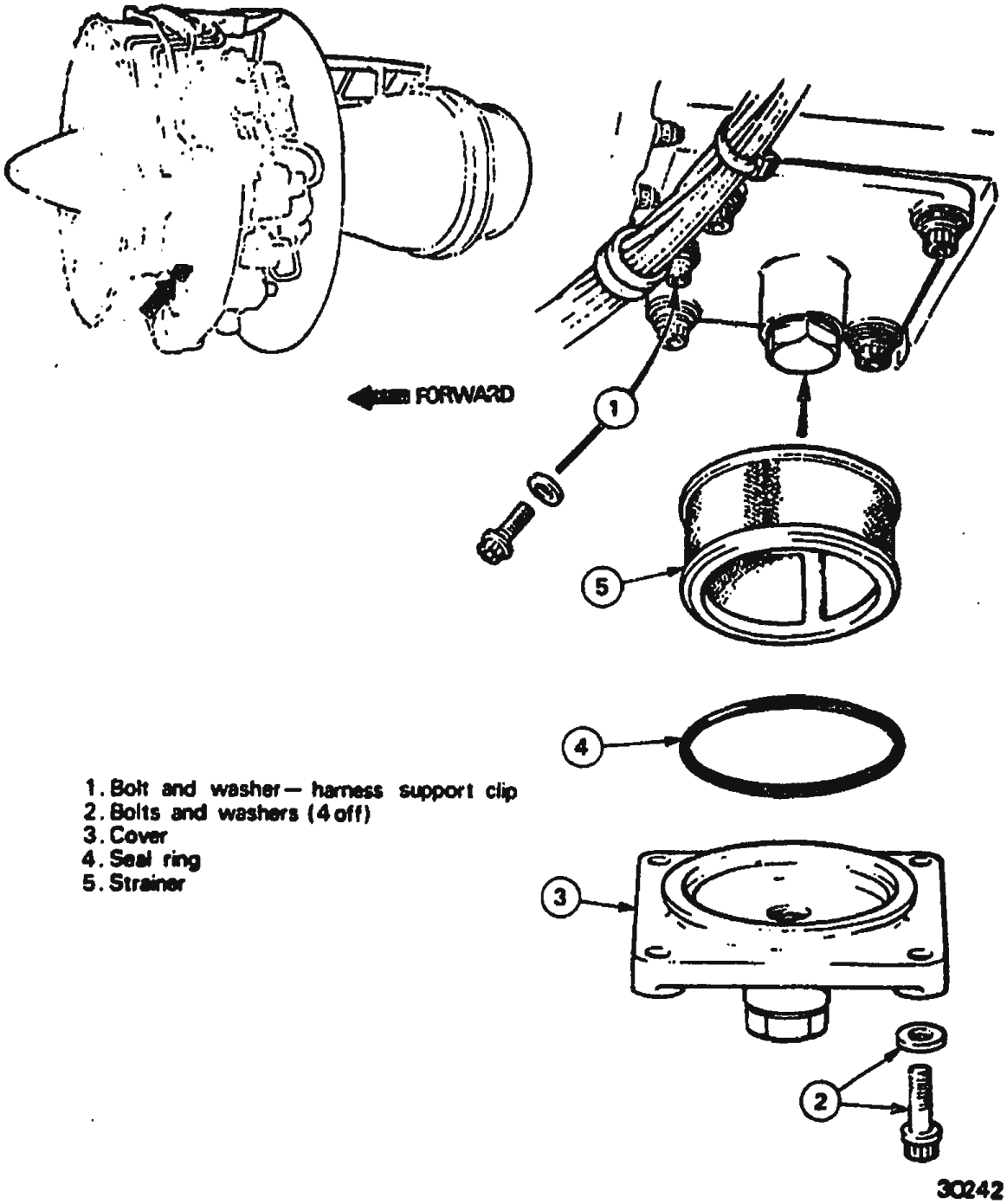
On engines without S.B.72-4557 or 72-7166 it is recommended that only filter elements which have been subject to ultrasonic cleaning procedure (Ref. 72-01-00, Cleaning/Painting) be installed. If this is not possible, or a previously unused element is to be installed, then the
R following operations are to be performed.

(1) Equipment required:

Compressed air supply

(2) Material required:

Clean kerosine




1. Bolt and washer — harness support clip
2. Bolts and washers (4 off)
3. Cover
4. Seal ring
5. Strainer

Pressure pump strainer - Removal/Installation
Fig.405

(3) Engines without S.B.72-4557 or 72-7166 refer to fig.404, wash element (3) in clean kerosine and dry with moisture free compressed air.

Engines with S.B.72-4557 or 72-7166
CAUTION: FILTER ELEMENTS MUST NOT BE REINSTALLED. A NEW ELEMENT MUST BE INSTALLED AND THE OLD ELEMENT DISCARDED. CLEANING PROCESSES ARE NOT PERMITTED ON THIS ELEMENT.

(4) Wash end cover (2) in clean kerosine and wipe clean.

(5) Fit and lubricate (Ref. 70-02-01) new seal ring (4) to end cover (2).

C. Install Pressure Filter Element

(1) Material required:

Clean engine oil (Ref. 12-12-01)

(2) Refer to fig.404, immerse element (3) in clean engine oil.

(3) Fit element in end cover (2) and position in filter housing.

(4) Secure assembly with bolts (1).

(5) Replenish oil system (Ref. 12-12-01).

(6) Close left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

. C (7) Perform Oil Leak Test No.5 (Ref. 71-00-00).

6. Removal/Installation Pressure Pump Strainer

The following operations detail two separate removal/ installation procedures for the pressure pump strainer before and after incorporation of S.B.71-2565.

Service Bulletins referred to:

71-2565 - Introduction of Gravity Filler Overspill Drain Tube
71-2917 - Extended Scupper Drain Tube

Referenced Procedures:

| | | |
|---|---|---|
| | 12-12-01 | Engine Oil Replenishment |
| | 70-02-01 | Identification, Lubrication and Fitting of Rubber Sealing Rings |
| | 70-51-00 | Torque Tightening Technique |
| R | 71-00-00 | Power Plant - Adjustment/Test |
| | 71-11-00 | Cowlings, Engines No.1 and No.3 - Servicing |
| | 71-12-01 | L.H. and R.H. Lower Hinged Cowl - Servicing |
| R | 72-01-00 | Oil System - Servicing and Inspection/Check |

Illustrated Parts Catalogue References:

The I.P.C. section where parts disturbed during the following operations can be located are as follows:

| | |
|---|---|
| 71-70-02 | Engine Drain Tubes and Fittings |
| 72-63-00 | H.S. External Gearbox |

A. Remove Pressure Pump Strainer (Engines not incorporating S.B.71-2565).

(1) Open left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

R (2) Drain oil tank (Ref. 72-01-00 Servicing).

(3) Refer to fig.405, remove harness support clip bolt and washer (1).

(4) Remove bolts and washers (2) and cover (3) then withdraw strainer (5).

(5) Inspect pressure pump strainer (Ref. 72-01-00 Inspection/Check).

B. Prepare for Installation

(1) Equipment required:

Compressed air supply

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid Methylethylketone (M.E.K.) | B.S.1940 1968 | - | 135 |
| or Acetone | B.S.509: 1964 | - | 150 |
| or Methylene Chloride (Dichloromethane) | B.S.1994: 1953 | - | 169 |

Clean kerosine

(3) Refer to fig.405, wash strainer (5) in clean kerosine and dry with moisture free compressed air.

(4) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.

CAUTION: CARE MUST BE TAKEN WHEN APPLYING THE SOLVENT AS THE SURFACE PROTECTION WILL BE AFFECTED. ANY AFFECTED AREAS MUST BE REPROTECTED IN
R ACCORDANCE WITH 70-42-12, LOCAL SURFACE
R PROTECTION.

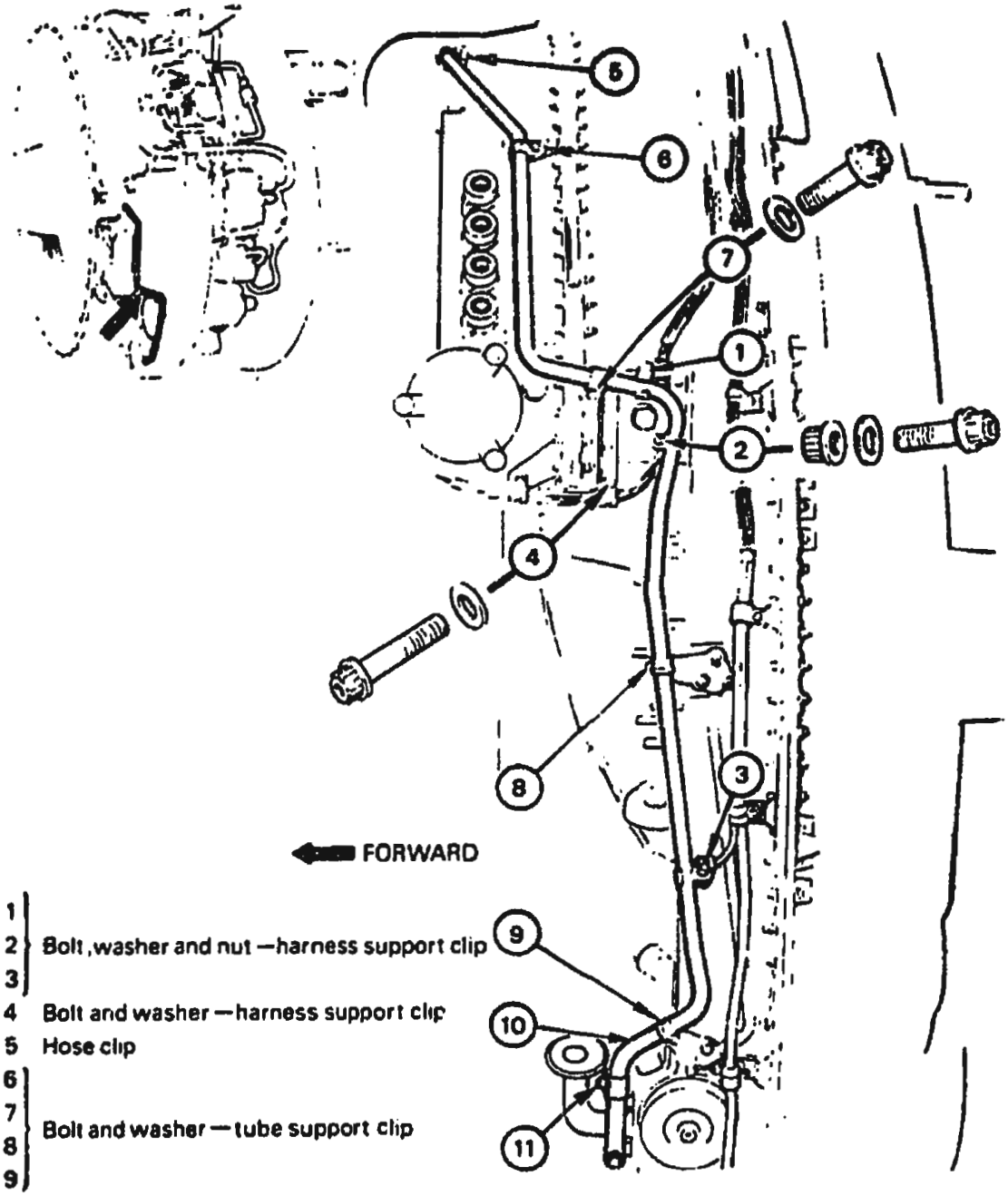
Using degreasing fluid, clean mating faces of cover (3) and oil tank, and allow to dry.

(5) Fit and lubricate (Ref. 70-02-01) new seal ring (4) to cover (3).

C. Install Pressure Pump Strainer (Engines not incorporating S.B.71-2565).

(1) Equipment required:

Clean, stiff-bristled brush




Drain tube disconnect points
(S.B.71-2565)
Fig.406

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Jointing compound | DTD.900/4586 (Hylomar light) PL.32 | - | 4/46 |
| Clean engine oil | (Ref. 12-12-01) | | |

(3) CAUTION: ENSURE JOINTING COMPOUND DOES NOT ENTER OIL TANK.
Refer to fig.405, brush apply a thin film of jointing compound to mating faces of cover (3) and oil tank; allow compound to dry for a minimum period of 10 minutes.

(4) Immerse strainer (5) in clean engine oil.

(5) Fit strainer (5) on cover (3) and position in oil tank ensuring correct location with pump inlet. Secure with bolts and washers (2) (Ref. 70-51-00).

(6) Secure harness support clip to bracket with bolt and washer (1).

(7) Replenish oil system (Ref. 12-12-01).

(8) Close left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

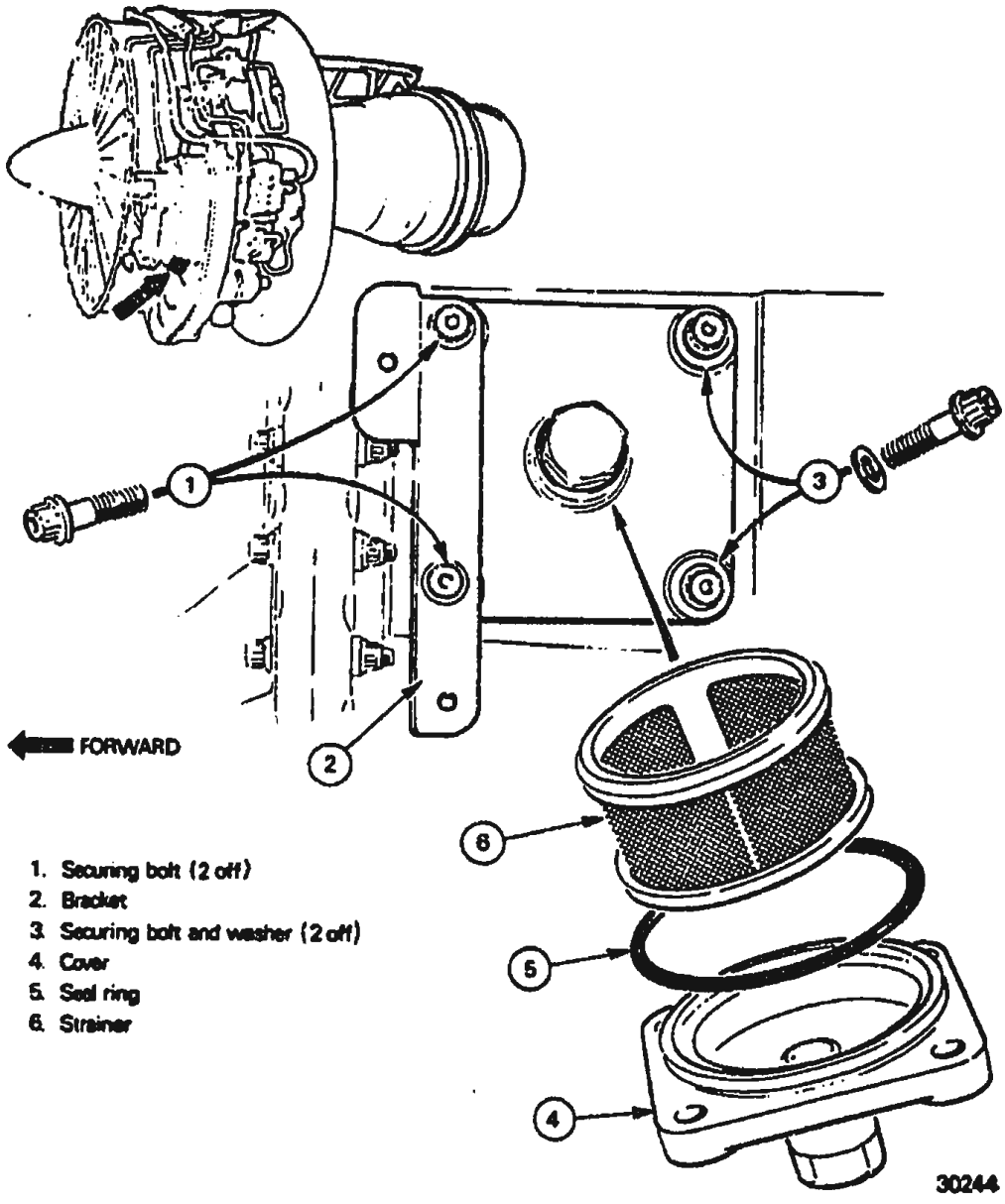
. C (9) Perform Oil Leak Test No.5 (Ref. 71-00-00).

D. Remove Pressure Pump Strainer (Engines incorporating S.B.71-2565).

(1) Open left-hand hinged cowl, 413A or 423A for engine No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

(2) Drain oil tank (Ref. 72-01-00 Servicing).

(3) Refer to fig.406, remove bolts, nuts and washers (1), (2) and (3). Leave clips on harness.




1. Securing bolt (2 off)
2. Bracket
3. Securing bolt and washer (2 off)
4. Cover
5. Seal ring
6. Strainer

Pressure pump strainer - Removal/Installation
(S.B.71-2565)
Fig.407

(4) Remove bolt and washer (4).

(5) Slacken off clip (5).

(6) Remove bolts and washers (6), (7), (8) and (9), then remove tube (10).

On engines incorporating S.B.71-2917, remove bolts and washers (6), (7), (8), (9) and (11) then remove tube (10).

(7) Refer to fig.407 remove bolts (1) and bracket (2).

(8) Remove bolts and washers (3), cover (4) and withdraw strainer (6).

(9) Inspect pressure pump strainer (Ref. 72-01-00 Inspection/Check).

E. Prepare for Installation

(1) Equipment required:

Compressed air supply

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid Methylethylketone (M.E.K.) | B.S.1940 1968 | - | 135 |
| or Acetone | B.S.509: 1964 | - | 150 |
| or Methylene Chloride (Dichloromethane) | B.S.1994: 1953 | - | 169 |

Clean kerosine

(3) Refer to fig.407, wash strainer (6) in clean kerosine and dry with moisture free compressed air.

(4) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.

CAUTION: CARE MUST BE TAKEN WHEN APPLYING THE SOLVENT AS THE SURFACE PROTECTION WILL BE AFFECTED. ANY AFFECTED AREAS MUST BE REPROTECTED IN
R ACCORDANCE WITH 70-42-12, LOCAL SURFACE
R PROTECTION.

Using degreasing fluid, clean mating faces of cover (4) and oil tank and allow to dry.

(5) Fit and lubricate (Ref. 70-02-01) new seal ring (5) to cover (4).

F. Install Pressure Pump Strainer (Engines incorporating S.B.71-2565).

(1) Equipment required:

Clean, stiff-bristled brush

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Jointing compound | DTD.900/4586 (Hylomar light) PL.32 | - | 4/46 |
| Clean engine oil | (Ref. 12-12-01) | | |

(3) CAUTION: ENSURE JOINTING COMPOUND DOES NOT ENTER OIL TANK.

Refer to fig.407, brush apply a thin film of jointing compound to mating faces of cover (4) and oil tank; allow compound to dry for a minimum period of 10 minutes.

(4) Immerse strainer (6) in clean engine oil.

(5) Fit strainer (6) on cover (4) and position in oil tank ensuring correct location with pump inlet. Secure (Ref. 70-51-00) with bolts and washers (3) and with bolts (1). Interpose bracket (2) between bolts (1) and cover (4).

(6) Refer to fig.406, position tube (10) then fit and secure bolts and washers (6), (7), (8) and (9).

On engines incorporating S.B.71-2917 also fit and secure bolt and washer (11).

(7) Tighten clip (5).

(8) Secure harness support clips to tube with bolts, washers and nuts (1), (2) and (3).

(9) Secure harness support clip to bracket with bolt and washer (4).

(10) Replenish oil system (Ref. 12-12-01).

(11) Close left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

. C (12) Perform Oil Leak Test No.5 (Ref. 71-00-00).

7. Removal/Installation Distributor Block

Service Bulletin referred to:

75-2042 - H.P. Compressor Bleed Valve Control System - Re-run Air Tubes

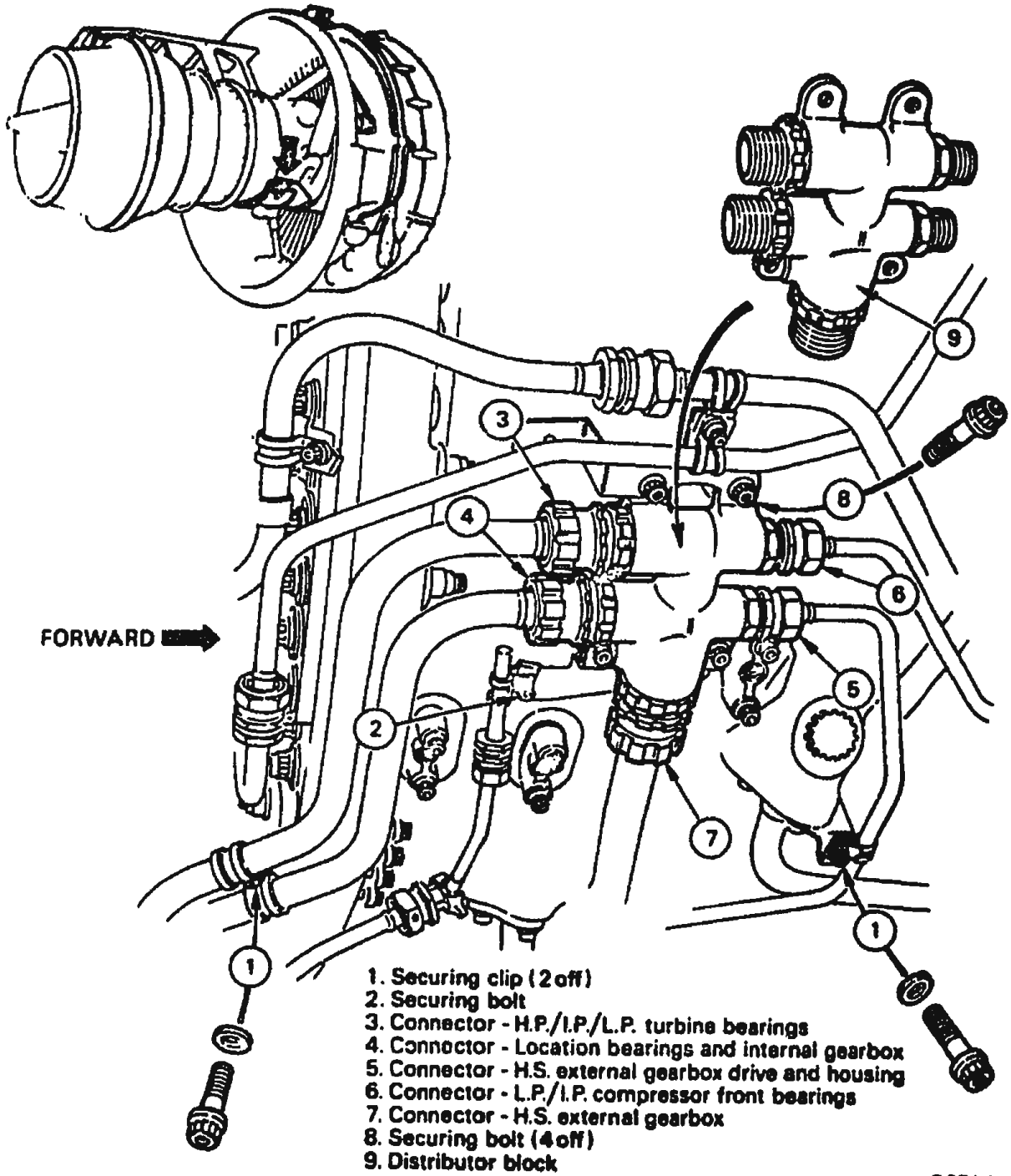
Referenced Procedures:

| | |
|---|---|
| 70-51-00 | Torque Tightening Technique |
| 71-00-00 | Power Plant - Adjustment/Test |
| 72-03-00 | Gas Generator Fairings - Removal/Installation |
| 78-30-00 | Thrust Reverser - Servicing |

Illustrated Parts Catalogue References:

The I.P.C. section where parts disturbed during the following operations can be located is as follows:

72-01-01 Oil System Tubes and Fittings




1. Securing clip (2 off)
2. Securing bolt
3. Connector - H.P./I.P./L.P. turbine bearings
4. Connector - Location bearings and internal gearbox
5. Connector - H.S. external gearbox drive and housing
6. Connector - L.P./I.P. compressor front bearings
7. Connector - H.S. external gearbox
8. Securing bolt (4 off)
9. Distributor block

30700

Distributor block - Removal/Installation
Fig.408

A. Remove Distributor Block

(1) Equipment required:

| | |
|---|---|
| 289200 or C 4G 4342 | Protective work mats |
| UT.630/1 | Spanner |
| UT.818 | Spanner |
| Clean receptacle - minimum capacity | |
| 1.2 U.S. pints | |
| 1.0 Imperial pints | |
| 0.5 Litres | |

(2) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems and fit thrust reverser mechanical locks (Ref. 78-30-00).

(3) Position work mats in cold stream duct.

(4) Remove compressor section rear fairing (Ref. 72-03-00).

(5) Refer to fig.408, release clips (1).

(6) On engines not incorporating S.B.75-2042, slacken bolt (2).

(7) Position receptacle and using spanner UT.630/1, disconnect connectors (3) and (4).

(8) Disconnect connectors (5) and (6).

(9) Using spanner UT.818, disconnect connector (7).

(10) Remove securing bolts (8) and withdraw distributor block (9).

(11) Fit approved blanks to all exposed apertures.

B. Install Distributor Block

(1) Equipment required:

Clean, stiff-bristled brush

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid Methylethylketone (M.E.K.) | B.S.1940 1968 | - | 135 |
| or Acetone | B.S.509: 1964 | - | 150 |
| or Methylene Chloride (Dichloromethane) | B.S.1994: 1953 | - | 169 |
| Jointing compound | DTD.900/ 4586 Hylomar light PL.32 | - | 4/46 |
| Lockwire | DTD.189A 22 S.W.G. | 21 A.W.G. | 238 |

(3) Ensure thrust reverser is locked and systems are deactivated and tagged as detailed in operation 7.A.(2).

(4) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.

CAUTION : CARE MUST BE TAKEN WHEN APPLYING THE SOLVENT AS THE SURFACE PROTECTION WILL BE AFFECTED. ANY AFFECTED AREAS MUST BE REPROTECTED IN
R ACCORDANCE WITH 70-42-12, LOCAL SURFACE
R PROTECTION.

Refer to fig.408, using degreasing fluid clean mating faces of distributor block (9) and compressor case and allow to dry.

(5) Brush apply a thin film of jointing compound to mating faces of distributor block and compressor case; allow to dry for a minimum period of 10 minutes.

(6) Remove blanks, if fitted, from all apertures.

(7) Position distributor block on case, and ensuring bracket(s) are correctly located, secure with bolts (8) (Ref. 70-51-00).

(8) Using spanner UT.818, connect and secure (Ref. 70-51-00) connector (7) and wirelock.

(9) Connect and secure (Ref. 70-51-00) connectors (6) and (5) and wirelock.

(10) Using spanner UT.630/1, connect and secure (Ref. 70-51-00) connectors (4) and (3) and wirelock.

(11) On engines not incorporating S.B.75-2042, tighten bolt (2).

(12) Secure clips (1).

C (13) Prepare to perform Oil Leak Test No.5 (Ref. 71-00-00) by applying chalk mixture to disturbed oil tube connectors.

(14) Install compressor section rear fairing (Ref. 72-03-00).

(15) Remove work mats from cold stream duct.

(16) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00).

C (17) Test engine and perform Oil Leak Test No.5 (Ref. 71-00-00).

# OIL SYSTEM - ADJUSTMENT/TEST

WARNING: THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE MAY CAUSE IRRITATION IF SKIN CONTACT IS REPEATED OR PROLONGED.

CAUTION: 1. THE OIL SPECIFIED FOR USE IN THIS OIL SYSTEM IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS OF THE ENGINE NOT NORMALLY IN CONTACT WITH IT. ANY OIL SPILT DURING SERVICING MUST BE WIPED UP IMMEDIATELY.

2. CONTAMINATION BY MINUTE AMOUNTS OF CERTAIN ALKALINE CLEANING FLUIDS CAN CAUSE COMPLETE BREAKDOWN OF THE SYNTHETIC OIL. USE SCRUPULOUSLY CLEAN CONTAINERS AND EQUIPMENT.

Service Bulletins referred to:

S.B.72-2919 - Introduction of convection cooling duct.
S.B.72-3221 - Introduction of additional restrictor in oil feed tube.
S.B.72-2911 - Oil jet housing with extended fine limit diameter.
S.B.72-6798 - Strengthened oil distributor with twin axial jets.

The procedures described in this section are listed below. The preparation and completion operations must still be performed should an individual procedure be carried out.

| Paragraph | Procedure |
|---|---|
| 1. | Functionally test oil distribution system. |
| A. | Equipment required. |
| B. | Air flow rig preparation and use. |
| C.(1) to (8) | Preparation operations. |
| C.(9) | Test H.P./I.P./L.P. turbines bearings oil distribution system. |
| C.(10) | Test location bearings and internal gearbox oil distribution system. |
| C.(11) | Test H.S. external gearbox drive and housing oil distribution system. |
| C.(12) | Test L.P./I.P. compressor front bearings oil distribution system. |
| C.(13) | Test H.S. external gearbox oil distribution system. |
| C.(14) to (20) | Completion operations. |

## 1. Functionally Test Oil Distribution System

To assist troubleshooting high or low oil pressure faults, the oil distribtuion system of each module may be tested by using a measured air flow.

This is achieved by using a portable air flow rig comprising air controls with pressure indication, a flowmeter and hoses. Each module is first purged and then air flow tested and the result is compared to the given limits. A reduction in air flow is indicative of a blockage and an increase in air flow of excessive leakage.

A. Equipment required:

R HU.21449/1 )
R or ) Air flow rig
R HU.25445/1 )
R Air supply 400-1000 kPa (60-150 p.s.i.)

B. Air flow rig preparation and use

(1) Refer to fig.501, ensure function switch is OFF and top of float indicator is level with red datum line.

NOTE: If float indicator is not aligned with datum line, release flowmeter cover quick-release fasteners (2 off); slacken flowmeter scale screws (2 off) and re-align datum line with top of float indicator. Tighten scale screws then fit and secure flowmeter cover.

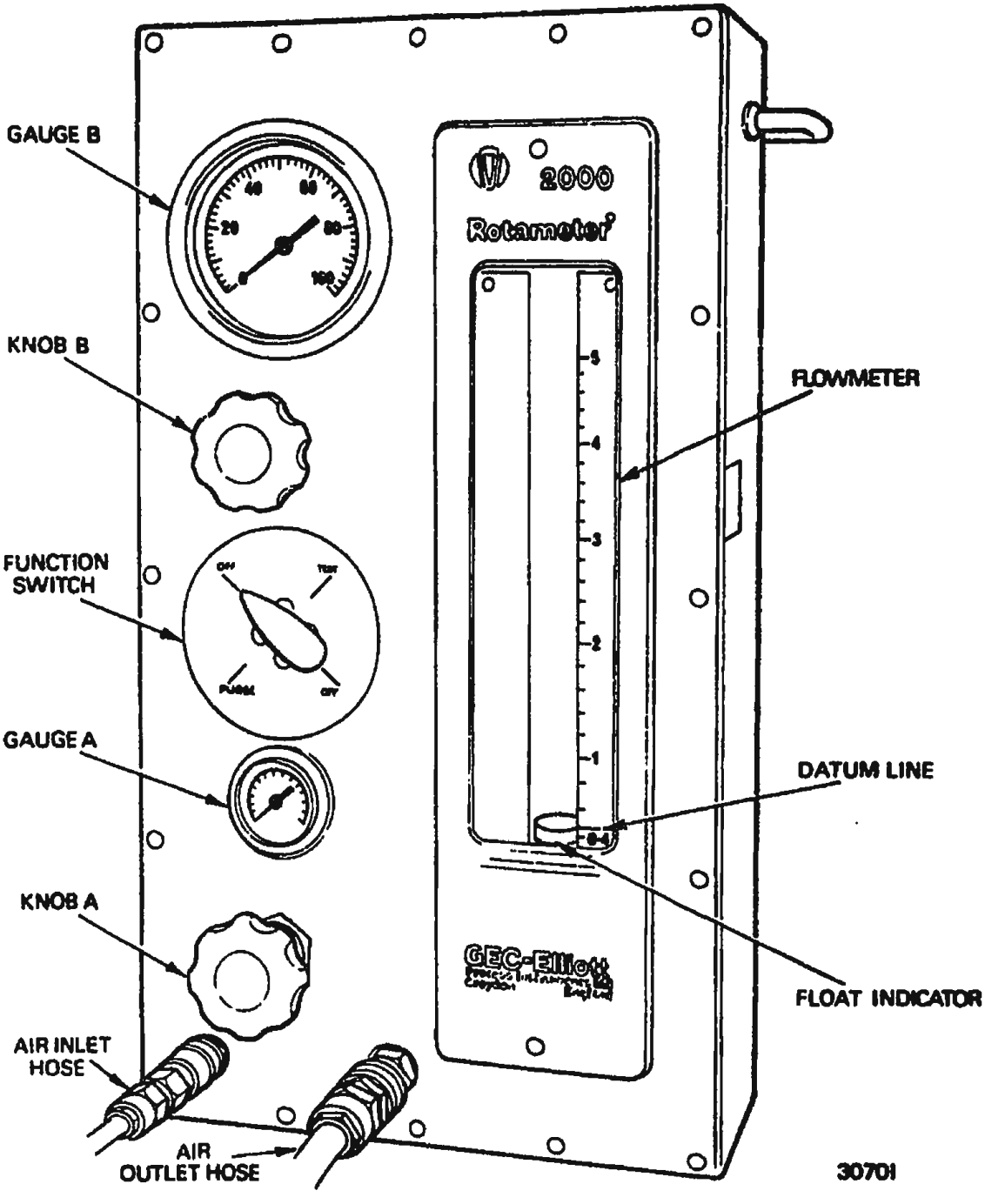
(2) Connect air inlet hose

(a) Offer hose coupling to rig, turn coupling clockwise, push forward and turn anti-clockwise; this final movement opens the air valve in the coupling.

(b) Connect other end of hose to air supply and turn air on.

(3) Connect air outlet hose

(a) Offer hose coupling to rig, slide black ring rearwards, push coupling forwards and release black ring to lock coupling in position.




Air flow rig
Fig.501

(b) Connect other end of hose, using same procedure as (a) above, to required position on engine (Ref. operations C (9) through (13)).

NOTE: The air outlet hose is calibrated to the rig for the length supplied.

(4) Select PURGE on function switch, slowly rotate knob A clockwise until gauge A indicates 100-140 kPa (18-20 p.s.i.); purge system for 2 minutes.

NOTE: If pressure fails to rise, ensure inlet hose coupling is correctly connected (Ref. para. (2)(a)).

(5) Rotate knob A anti-clockwise until gauge A indicates zero.

(6) Select TEST on function switch, slowly rotate knob B clockwise until gauge B indicates exactly 50 kPa.

(7) Record flowmeter reading.

(8) Rotate knob B anti-clockwise until gauge B indicates zero.

(9) Select OFF on function switch, turn air supply off.

(10) Disconnect air inlet and outlet hoses reversing the procedure in para. (2) and (3).

C. Test Oil Distribution System

WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION (REF. 78-30-00, SERVICING) WHILE WORK IS IN PROGRESS.

(1) Equipment required:

| | |
|---|---|
| 289200 or C 4G 4342 | Protective work mats |
| HU.21411 | Plug |
| HU.21412 | Retainer |
| HU.21733 | Blank |

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Lockwire | DTD.189A 22 S.W.G. | - | 238 |
| R | | 21 A.W.G. | |

(3) Tag throttle control levers and thrust reverser levers. Tag APU/GND AIR TO REVERSERS switches.

(4) On pilots overhead circuit breaker panel CB1, zone 210, open and tag appropriate THRUST REVERSE circuit breaker.

(5) On Flight Engineers/Second Officer's aft circuit breaker panel CB3, zone 215, open and tag appropriate START AIR valve.

(6) Position work mats in cold stream duct.

(7) Remove compressor section rear fairing and combustion section lower and side fairings (Ref. 72-03-00, Removal/Installation).

(8) Remove distributor block (Ref. Removal/Installation).

(9) Test H.P./I.P./L.P. turbine bearings oil distribution system.

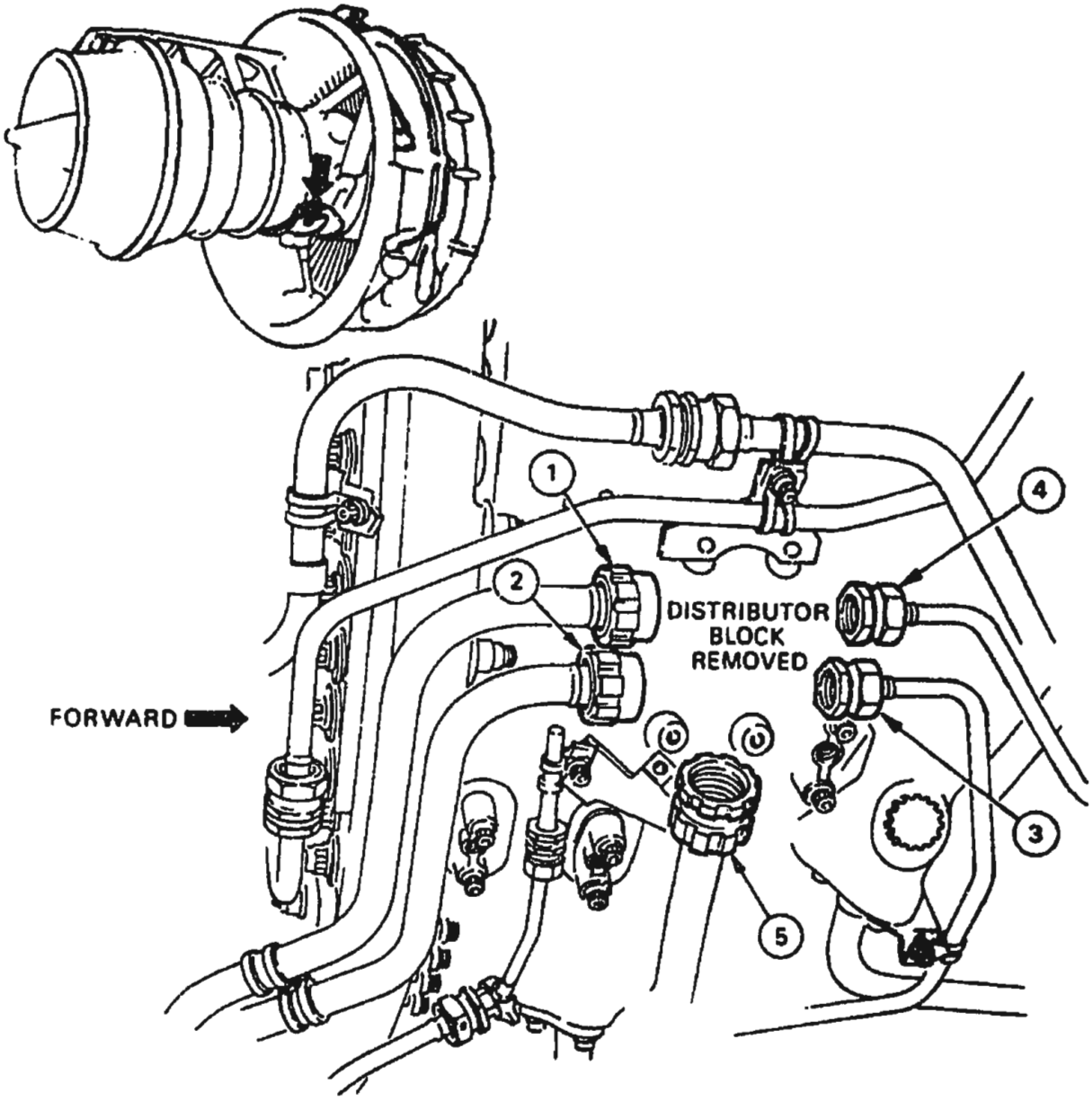
(a) Refer to fig.502, fit and secure adapter HU.21572 to connector (1).

(b) Prepare and use air flow rig (Ref. para.B.) and check flowmeter reading for complete turbine section.

(i) If reading is between 2.50 to 2.80 grammes/sec., proceed with operation (10).

(ii) If reading is outside 2.50 to 2.80 grammes/sec., proceed with operation (9)(c).

(c) Refer to fig.503, release bolt, washer and spacer (1) and bolt and washer (2).




1 Connector - H.P./I.P./L.P. turbine bearings
2 Connector - Location bearings and internal gearbox
3 Connector - H.S. external gearbox drive and housing
4 Connector - L.P./I.P. compressor front bearings
5. Connector - H.S. external gearbox

30702

Oil distribution system test points
Fig.502

(d) Disconnect tube connector (3) and fit blank HU.21733 to open end of tube connector.

(e) Operate air flow rig (Ref. para.B.) and check flowmeter reading for H.P./I.P. turbine bearings.

(i) If reading is outside 1.90 to 2.20 grammes/sec., reject engine for module 05 change (Ref. Heavy Maintenance Manual, 72-00-05).

(ii) If reading is between 1.90 to 2.20 grammes/sec., proceed with operation (f).

(f) Fit and secure adapter HU.21577 to L.P. turbine bearing oil inlet connector (4); remove rig air outlet hose from connector (1) (Ref. fig.502) hose to adapter.

(g) Operate air flow rig (Ref. para.B.) and check flowmeter reading for L.P. turbine bearing.

(i) If reading is outside 0.60 to 0.80 grammes/sec., reject engine for mini-module 05/3 change (Ref. Heavy Maintenance Manual, 72-51-03).

(ii) If reading is between 0.60 to 0.80 grammes/sec., and initial fault was high oil pressure, proceed with operation (9)(h) and check oil tube for blockage.

(iii) If reading is between 0.60 to 0.80 grammes/sec., and initial fault was low oil pressure, proceed with operation (9)(n).

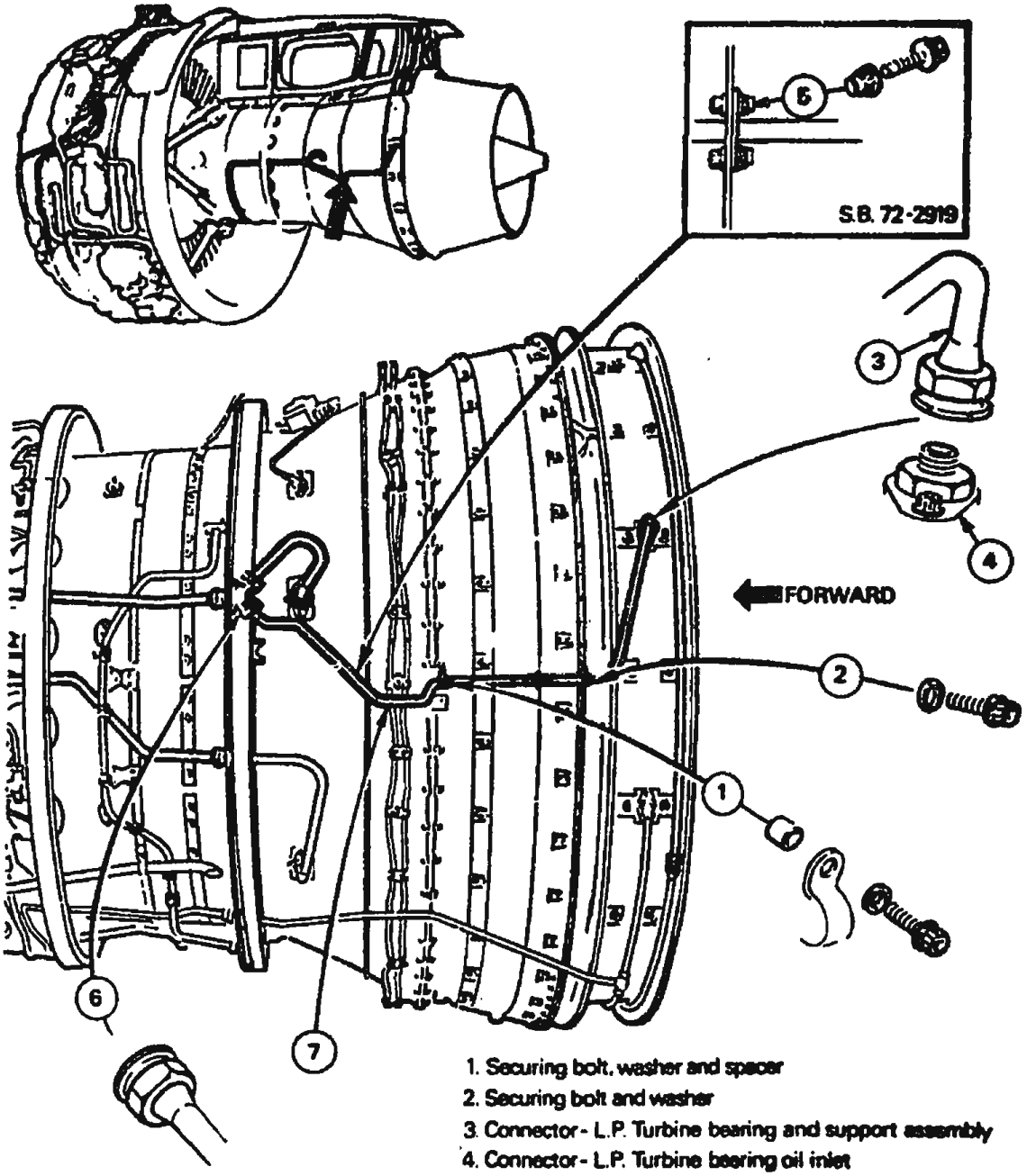
(h) Remove blank HU.21733 from connector (3).

(j) On engine incorporating S.B.72-2919, remove securing nuts and bolts (5).

(k) Disconnect connector (6) and remove tube (7).

(m) Blow through tube (7) using moisture free compressed air.

(n) Disconnect air outlet hose from adapter and remove adapter from connector (4).


S.B. 72-2919
FORWARD
1. Securing bolt, washer and spacer
2. Securing bolt and washer
3. Connector - L.P. Turbine bearing and support assembly
4. Connector - L.P. Turbine bearing oil inlet
5. Securing bolt and nut (2 off)
6. Connector - Y connection
7. Tube - Y connection to L.P. turbine bearings
30703

L.P. turbine bearings oil distribution system test point
Fig.503

(p) Position tube (7) on turbine case, connect and tighten (Ref. 70-51-00, para.10) connectors (6) and (3) and wirelock.

(q) On engines incorporating S.B.72-2919, fit and secure bolts and nuts (5).

(r) Position and secure bolt and washer (2) and bolt, washer and spacer (1).

(s) Refer to fig.502, remove adapter HU.21572 from tube (1).

(10) Test location bearings and internal gearbox oil distribution system.

(a) Refer to fig.502, fit and secure adapter HU.21572 to open end of tube (2).

(b) Prepare and use air flow rig (Ref. para.B.) and check flowmeter reading.

Engines without S.B.72-6798 if reading is outside 3.40 to 3.60 grammes/sec., reject engine for I.P./L.P. location bearings assembly change (Ref. Heavy Maintenance Manual, 72-33-01).

Engines with S.B.72-6798 if reading is outside 3.80 to 4.20 gramms/sec., reject engine for I.P./L.P. location bearings assembly change (Ref. Heavy Maintenance Manual, 72-33-01).

(c) Disconnect air outlet hose from adapter and remove adapter from tube (2).

(11) Test H.S. external gearbox drive and housing oil distribution system.

(a) Refer to fig.502, fit and secure adapter HU.21570 to open end of tube (3).

(b) Prepare and use air flow rig (Ref. para.B.) and check flowmeter reading is between 0.60 to 0.70 grammes/sec.

If reading is outside 0.60 to 0.70 grammes/sec., reject engine for mini-module 03/2 change (Ref. Heavy Maintenance Manual, 72-62-00).

(c) Disconnect air outlet hose from adapter and remove adapter from tube (3).

(12) Test L.P./I.P. compressor front bearings oil distribution system

(a) Refer to fig.502, fit and secure adapter HU.21570 to open end of tube (4).

(b) Prepare and use air flow rig (Ref. para.B.) and check flowmeter reading is between 0.90 to 1.20 grammes/sec.

If reading is outside 0.90 to 1.20 grammes/sec., reject engine for module 02/1 change (Ref. Heavy Maintenance Manual, 72-32-03).

(c) Disconnect air outlet hose from adapter and remove adapter from tube (4).

(13) Test H.S. external gearbox oil distribution system

(a) Remove pressure filter element (Ref. 72-01-00, Removal/Installation).

(b) Ensuring seal ring is in position on plug HU.21411, locate plug in filter housing chamber and secure in position with retainer HU.21412.

(c) Refer to fig.502, fit and secure adapter HU.21573 to open end of tube (5).

(d) Prepare and use air flow rig (Ref. para.B.) and check flowmeter reading.

(i) Engines not incorporating S.B.72-3221, reading should be between 3.30 to 3.60 grammes/sec.

(ii) Engines incorporating S.B.72-3221, reading should be between 2.70 to 3.00 grammes/sec.

(e) If reading is outside appropriate limits and engine incorporates S.B.72-2911, reject engine for module 06 change (Ref. Heavy Maintenance Manual, 72-00-06).

(f) If reading is outside appropriate limits, and initial fault was high oil pressure and engine does not incorporate S.B.72-2911, remove input drive oil jet (Ref. 72-63-00, Maintenance Practices) and check for blockage.

(i) If oil jet is clear, refit oil jet (Ref. 72-63-00, Maintenance Practices) and reject engine for module 06 change (Ref. Heavy Maintenance Manual, 72-00-06).

(ii) If oil jet is blocked, remove blockage, refit oil jet (Ref. 72-63-00, Maintenance Practices) and recheck flowmeter reading.

If reading is still outside limits, reject engine for module 06 change (Ref. Heavy Maintenance Manual, 72-00-06).

(g) Disconnect air hose from adapter and remove adapter from tube (5).

(h) Remove retainer and plug from filter housing chamber.

(j) Prepare and install pressure filter element (Ref. Removal/Installation).

(14) Install distributor block (Ref. Removal/Installation).

(15) Disassemble air flow rig (Ref. para.B.).

(16) Prepare to test engine (Ref. Adjustment/Test, Table 501) by applying chalk mixture to disturbed gas generator oil tube connectors.

(17) Install compressor section rear fairing and combustion section lower and side fairings (Ref. 72-03-00, Removal/Installation).

(18) Remove work mats from cold stream duct.

(19) Remove tags and close circuit breakers opened in operations C. (3) through (5).

(20) Test engine (Ref. Adjustment/Test, Table 501) and check disturbed gas generator oil tube connectors for leaks.

# OIL SYSTEM - INSPECTION/CHECK

## 1. General

WARNING: 1. THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE MAY CAUSE IRRITATION AFTER PROLONGED OR REPEATED SKIN CONTACT.

2. IMMEDIATELY AFTER SHUTDOWN ENGINE OIL TEMPERATURE REMAINS HIGH. THEREFORE, EXTREME CARE MUST BE OBSERVED WHEN WORKING NEAR TO OR ON ENGINE OIL SYSTEM COMPONENTS AND TUBES.

CAUTION: 1. THE OIL SPECIFIED FOR USE IN THIS OIL SYSTEM IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS OF THE ENGINE NOT NORMALLY IN CONTACT WITH IT. ANY OIL SPILT DURING SERVICING MUST BE WIPED UP IMMEDIATELY.

2. CONTAMINATION BY MINUTE AMOUNTS OF CERTAIN ALKALINE CLEANING FLUIDS CAN CAUSE COMPLETE BREAKDOWN OF THE SYNTHETIC OIL. USE SCRUPULOUSLY CLEAN CONTAINERS AND EQUIPMENT.

A. Service Bulletins referred to:

72-4889 - Increased Capacity Fine Scavenge Filter Element with Dirt Trap
72-6891 - Fine Scavenge Filter Element with Removable Dirt Trap
72-7654 - Oil Tank Cover - Deletion of Scavenge Strainers

B. References Procedures:

71-00-00, Adjustment/Test
72-01-00, Removal/Installation and Cleaning/Painting

C. Inspection of magnetic chip detectors and filter elements can give an early indication of internal engine failure.

D. The keeping of records provides a vital background to correct decision making when debris is found on MCD's or in filter elements. Therefore, all metallic debris found on MCD's or in filters which does not cause the immediate
C rejection of an engine or gearbox, should be returned to
C MCIEE to enable a trend analysis record to be maintained.

E. Magnetic chip detectors and filter elements should be inspected as detailed in Table 1 and 2.

2. Inspection Procedures

A. Magnetic Chip Detectors (MCD).

(1) Remove MCD (Ref.72-01-00, Removal/Installation).

(2) Wash MCD by immersing in clean kerosine in a non-metallic receptacle or by spraying with an approved solvent.

(3) Examine debris under a good light source using a magnifying glass (approximate magnification X5) or a binocular microscope.

(4) Any metallic debris found on MCD's which does not necessitate engine or gearbox rejection (swarf or fines covering less than half MCD circumference)
C should be returned to MCIEE for trend monitoring purposes.

(5) If following the discovery of metal particles on a detector the engine is rejected for suspected internal failure, the detector should be reinstalled in the
C engine and the debris made available to the overhaul
C shop and identified relative to its detector position.

(6) Clean MCD's ensure seal rings are in good condition and correctly fitted then install MCD's (Ref.72-01-00, Removal/Installation).

B. Fine Scavenge Filter

(1) Remove filter, (Ref.72-01-00, Removal/Installation) and collect drained oil in a clean container.

(2) Strain drained oil through a gauze cloth or a filter paper of finer mesh than the element.

R (3) Recover filter debris using one of the following methods:

R (a) On engines without S.B.72-4889 and S.B.72-6891 fine scavenge filters, remove funnels from each end of filter element.

R (b) On engines with S.B.72-4889 fine scavenge filters, the conical dirt trap feature should be held uppermost during debris recovery.

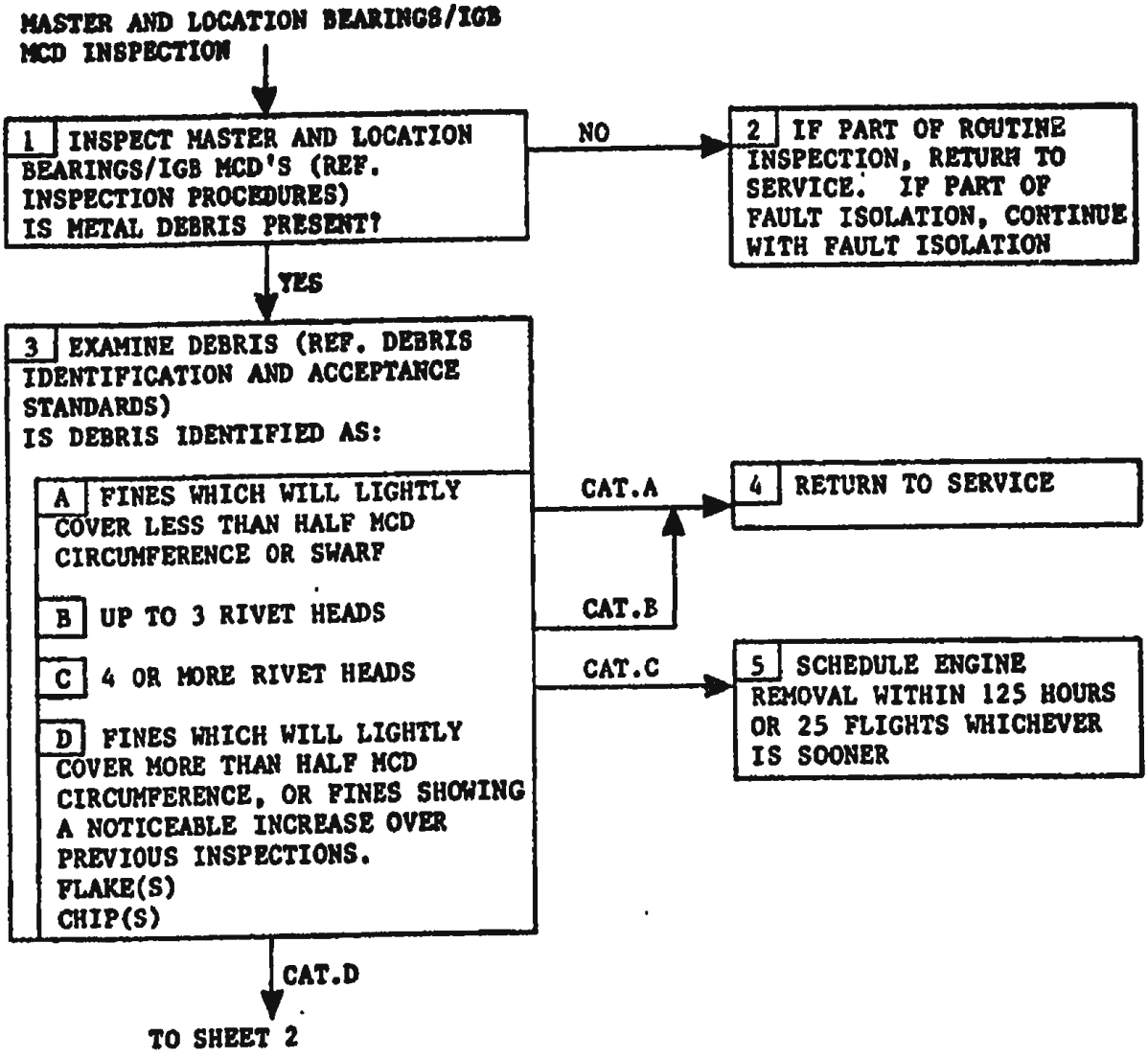
R (c) On engines with S.B.72-6891 fine scavenge filters, remove dirt trap (Ref.72-01-00, Removal/ Installation) from filter element.

R (d) Thoroughly wash the element and (if applicable) funnels or dirt trap in clean kerosine shaking and tapping the base to ensure all debris is freed from inside the elements folds. Strain the kerosine through a clean filter paper.

R (e) Carefully soak the element in clean kerosine and then dry. When dry, shake and tap the base on to a clean surface ensuring all debris is freed from inside the element.

R (4) Remove all debris from filter papers.

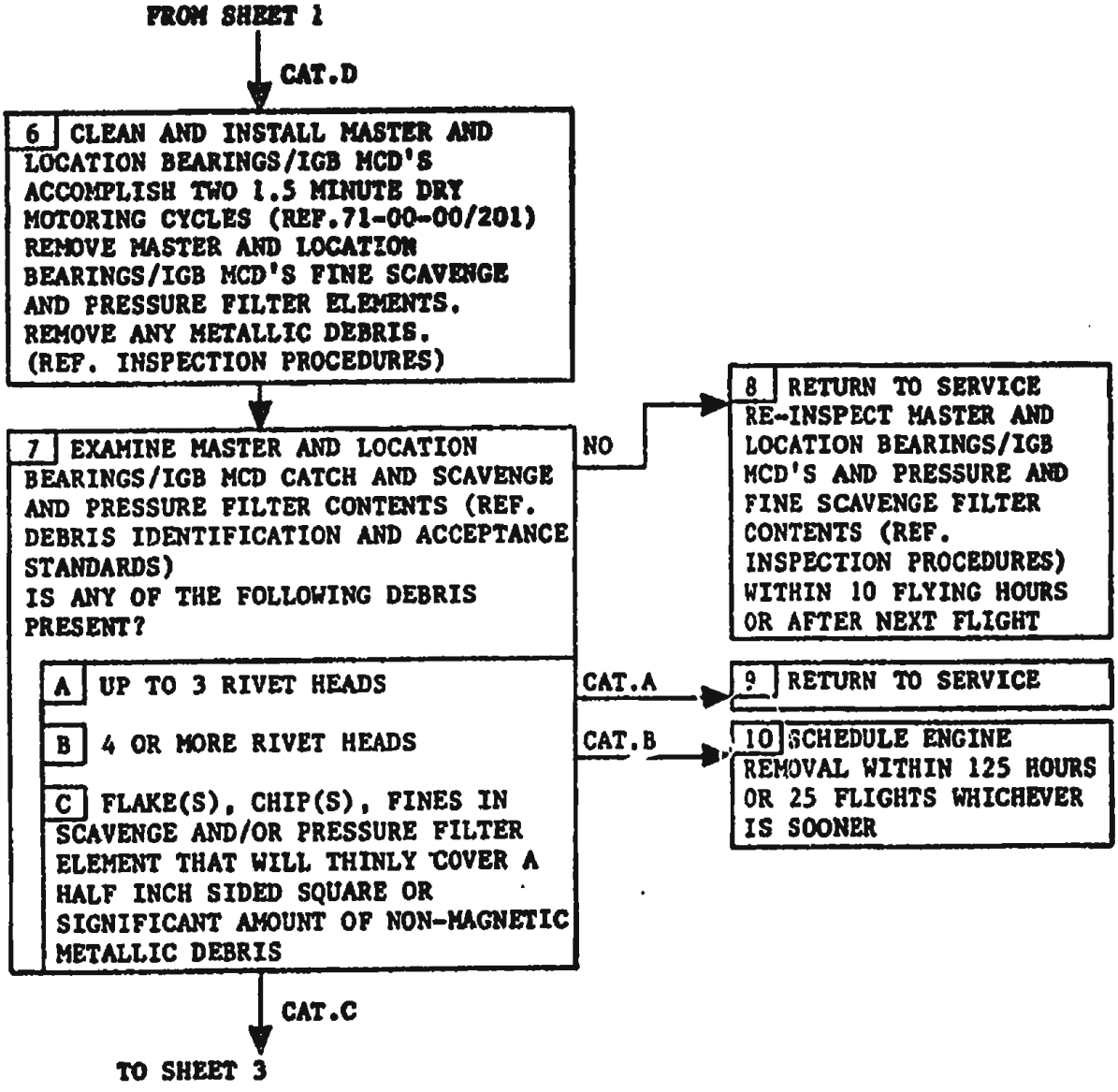
NOTE: Passing a magnet covered with tissue paper over the filtered contents will effectively extract any magnetic material.


MASTER AND LOCATION BEARINGS/IGB MCD INSPECTION
1 INSPECT MASTER AND LOCATION BEARINGS/IGB MCD'S (REF. INSPECTION PROCEDURES) IS METAL DEBRIS PRESENT?
NO
2 IF PART OF ROUTINE INSPECTION, RETURN TO SERVICE. IF PART OF FAULT ISOLATION, CONTINUE WITH FAULT ISOLATION
YES
3 EXAMINE DEBRIS (REF. DEBRIS IDENTIFICATION AND ACCEPTANCE STANDARDS) IS DEBRIS IDENTIFIED AS:
A FINES WHICH WILL LIGHTLY COVER LESS THAN HALF MCD CIRCUMFERENCE OR SWARF
B UP TO 3 RIVET HEADS
C 4 OR MORE RIVET HEADS
D FINES WHICH WILL LIGHTLY COVER MORE THAN HALF MCD CIRCUMFERENCE, OR FINES SHOWING A NOTICEABLE INCREASE OVER PREVIOUS INSPECTIONS.
FLAKE(S)
CHIP(S)
CAT.A
CAT.B
4 RETURN TO SERVICE
CAT.C
5 SCHEDULE ENGINE REMOVAL WITHIN 125 HOURS OR 25 FLIGHTS WHICHEVER IS SOONER
CAT.D
TO SHEET 2

79762B

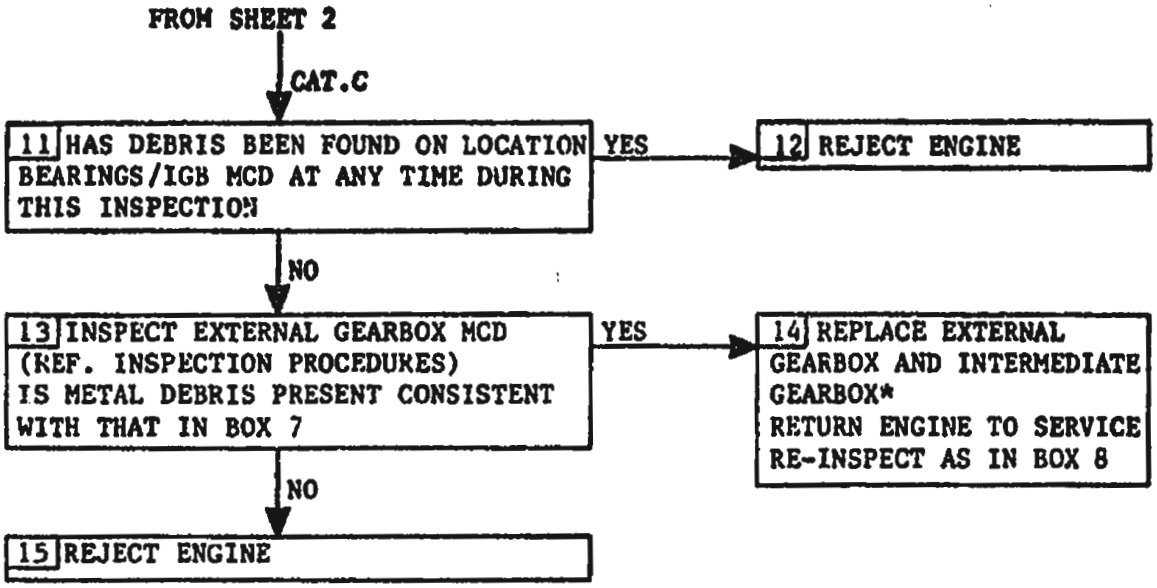
R Master and Location Bearings/Internal Gearbox - MCD Inspection
R Table 1 (Sheet 1)

EFFECTIVITY: ALL


FROM SHEET 1
CAT.D
6 CLEAN AND INSTALL MASTER AND LOCATION BEARINGS/IGB MCD'S ACCOMPLISH TWO 1.5 MINUTE DRY MOTORING CYCLES (REF.71-00-00/201) REMOVE MASTER AND LOCATION BEARINGS/IGB MCD'S FINE SCAVENGE AND PRESSURE FILTER ELEMENTS. REMOVE ANY METALLIC DEBRIS. (REF. INSPECTION PROCEDURES)
7 EXAMINE MASTER AND LOCATION BEARINGS/IGB MCD CATCH AND SCAVENGE AND PRESSURE FILTER CONTENTS (REF. DEBRIS IDENTIFICATION AND ACCEPTANCE STANDARDS)
IS ANY OF THE FOLLOWING DEBRIS PRESENT?
NO
8 RETURN TO SERVICE RE-INSPECT MASTER AND LOCATION BEARINGS/IGB MCD'S AND PRESSURE AND FINE SCAVENGE FILTER CONTENTS (REF. INSPECTION PROCEDURES) WITHIN 10 FLYING HOURS OR AFTER NEXT FLIGHT
A UP TO 3 RIVET HEADS
CAT.A
9 RETURN TO SERVICE
B 4 OR MORE RIVET HEADS
CAT.B
10 SCHEDULE ENGINE REMOVAL WITHIN 125 HOURS OR 25 FLIGHTS WHICHEVER IS SOONER
C FLAKE(S), CHIP(S), FINES IN SCAVENGE AND/OR PRESSURE FILTER ELEMENT THAT WILL THINLY COVER A HALF INCH SIDED SQUARE OR SIGNIFICANT AMOUNT OF NON-MAGNETIC METALLIC DEBRIS
CAT.C
TO SHEET 3

79763B

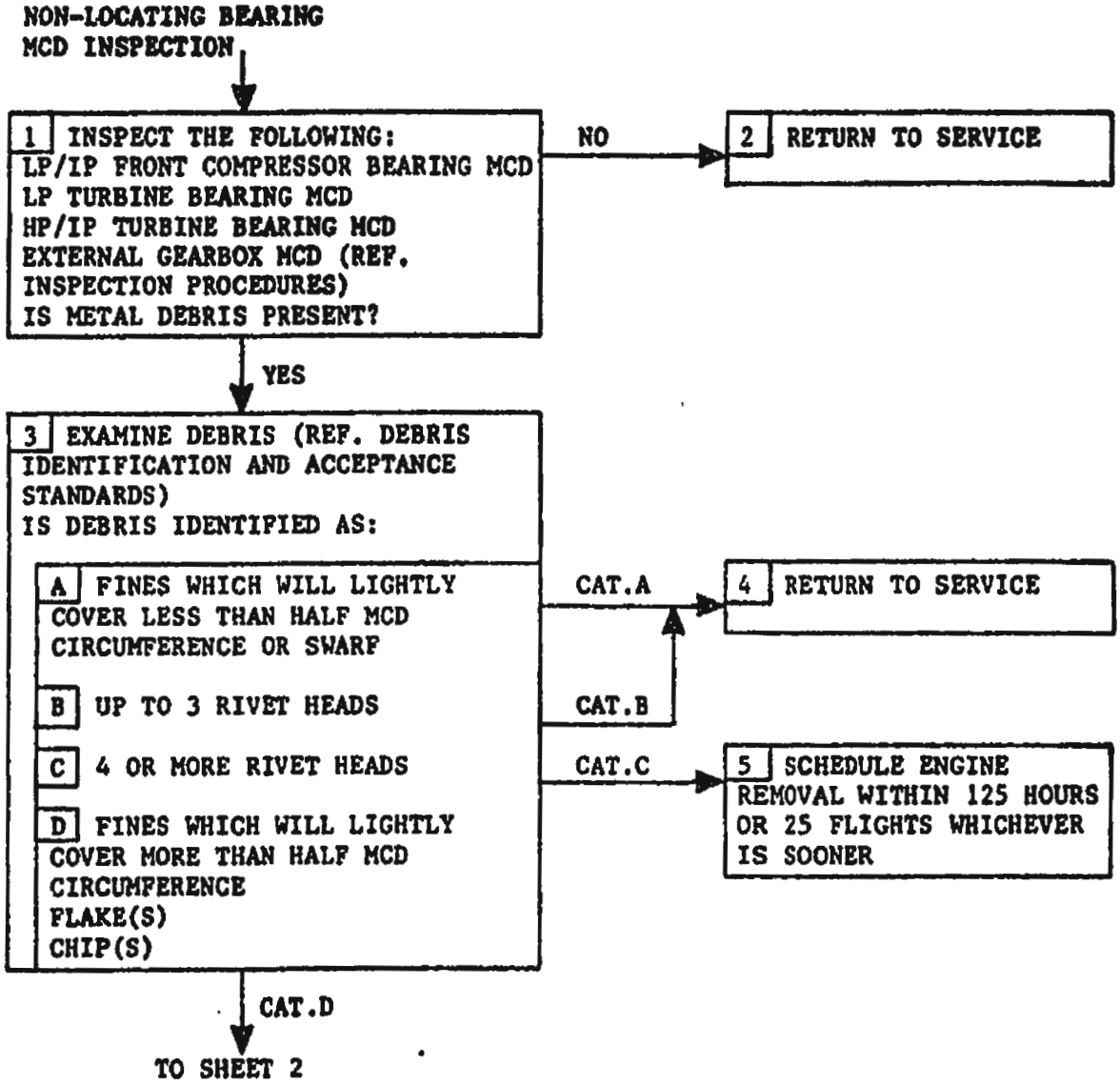
R Master and Location Bearings/Internal Gearbox - MCD Inspection
R Table 1 (Sheet 2)


FROM SHEET 2
CAT.C
11 HAS DEBRIS BEEN FOUND ON LOCATION BEARINGS/IGB MCD AT ANY TIME DURING THIS INSPECTION
YES
12 REJECT ENGINE
NO
13 INSPECT EXTERNAL GEARBOX MCD (REF. INSPECTION PROCEDURES) IS METAL DEBRIS PRESENT CONSISTENT WITH THAT IN BOX 7
YES
14 REPLACE EXTERNAL GEARBOX AND INTERMEDIATE GEARBOX*
RETURN ENGINE TO SERVICE
RE-INSPECT AS IN BOX 8
NO
15 REJECT ENGINE

* IF CHIPS FOUND CAN BE POSITIVELY IDENTIFIED AS GEAR TOOTH CORNERS NOT EXCEEDING 5MM X 5MM X 5MM, THE GEARBOX CAN BE RETAINED IN SERVICE AND THE DEFECTIVE GEARSHAFT REPLACED AT NEXT SHOP VISIT.

79766

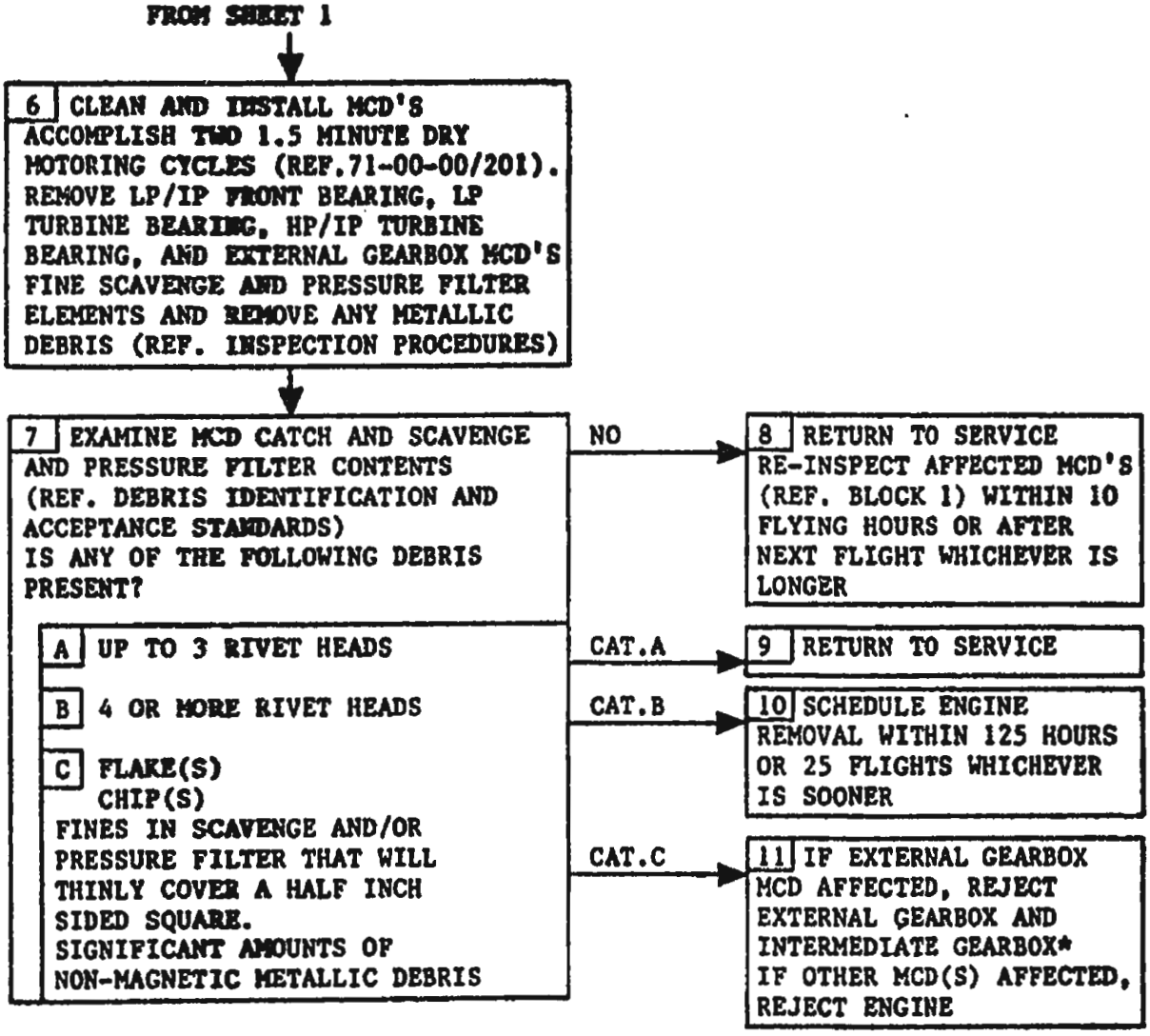
R
R
R Master and Location Bearings/Internal Gearbox - MCD Inspection
Table 1 (Sheet 3)


NON-LOCATING BEARING
MCD INSPECTION
1 INSPECT THE FOLLOWING:
LP/IP FRONT COMPRESSOR BEARING MCD
LP TURBINE BEARING MCD
HP/IP TURBINE BEARING MCD
EXTERNAL GEARBOX MCD (REF. INSPECTION PROCEDURES)
IS METAL DEBRIS PRESENT?
NO
2 RETURN TO SERVICE
YES
3 EXAMINE DEBRIS (REF. DEBRIS IDENTIFICATION AND ACCEPTANCE STANDARDS)
IS DEBRIS IDENTIFIED AS:
A FINES WHICH WILL LIGHTLY COVER LESS THAN HALF MCD CIRCUMFERENCE OR SWARF
B UP TO 3 RIVET HEADS
C 4 OR MORE RIVET HEADS
D FINES WHICH WILL LIGHTLY COVER MORE THAN HALF MCD CIRCUMFERENCE
FLAKE(S)
CHIP(S)
CAT.A
CAT.B
4 RETURN TO SERVICE
CAT.C
5 SCHEDULE ENGINE REMOVAL WITHIN 125 HOURS OR 25 FLIGHTS WHICHEVER IS SOONER
CAT.D
TO SHEET 2

68491D

R
R Non Location Bearing - MCD Inspection
Table 2 (Sheet 1)

EFFECTIVITY: ALL


FROM SHEET 1
6 CLEAN AND INSTALL MCD'S
ACCOMPLISH TWO 1.5 MINUTE DRY MOTORING CYCLES (REF.71-00-00/201).
REMOVE LP/IP FRONT BEARING, LP TURBINE BEARING, HP/IP TURBINE BEARING, AND EXTERNAL GEARBOX MCD'S
FINE SCAVENGE AND PRESSURE FILTER ELEMENTS AND REMOVE ANY METALLIC DEBRIS (REF. INSPECTION PROCEDURES)
7 EXAMINE MCD CATCH AND SCAVENGE AND PRESSURE FILTER CONTENTS (REF. DEBRIS IDENTIFICATION AND ACCEPTANCE STANDARDS)
IS ANY OF THE FOLLOWING DEBRIS PRESENT?
A UP TO 3 RIVET HEADS
B 4 OR MORE RIVET HEADS
C FLAKE(S)
CHIP(S)
FINES IN SCAVENGE AND/OR PRESSURE FILTER THAT WILL THINLY COVER A HALF INCH SIDED SQUARE.
SIGNIFICANT AMOUNTS OF NON-MAGNETIC METALLIC DEBRIS
NO
8 RETURN TO SERVICE
RE-INSPECT AFFECTED MCD'S (REF. BLOCK 1) WITHIN 10 FLYING HOURS OR AFTER NEXT FLIGHT WHICHEVER IS LONGER
CAT.A
9 RETURN TO SERVICE
CAT.B
10 SCHEDULE ENGINE REMOVAL WITHIN 125 HOURS OR 25 FLIGHTS WHICHEVER IS SOONER
CAT.C
11 IF EXTERNAL GEARBOX MCD AFFECTED, REJECT EXTERNAL GEARBOX AND INTERMEDIATE GEARBOX*
IF OTHER MCD(S) AFFECTED, REJECT ENGINE

* IF CHIP(S) FOUND CAN BE POSITIVELY IDENTIFIED AS GEAR TOOTH CORNERS NOT EXCEEDING 5MM X 5MM X 5MM, THE GEARBOX CAN BE RETAINED IN SERVICE AND THE DEFECTIVE GEARSHAFT REPLACED AT NEXT SHOP VISIT.

68492E

R Non Location Bearing - MCD Inspection
R Table 2 (Sheet 2)

(5) If the element is free of metal particles and the engine is to continue in service, with a light illuminating the inside of the element and using a glass of X5 magnification, inspect the elements for carbon deposits. If significant amounts of carbon are apparent replace filter (Ref.72-01-00, Removal/Installation) and perform Test 17 (Ref.71-00-00, Adjustment/Test).

NOTE: In the interests of operational requirements, kerosine washed scavenge filters may be refitted to the engine provided any excess kerosine is shaken off. Any filter so replaced must be exchanged for a filter cleaned as detailed in 72-01-00, Cleaning/Painting, within 25 hours.

C. Pressure Filter

(1) Remove pressure filter (Ref.72-01-00, Removal/Installation) and collect drained oil in a clean container.

(2) Strain drained oil through a gauze cloth or filter paper of finer mesh than the filter element.

(3) Recover filter debris using one of the following methods:

(a) Thoroughly wash the element and housing end cover in clean kerosine, shaking and tapping the base to ensure all debris is freed from inside the element folds. Strain the kerosine through a clean filter paper.

(b) Carefully soak the element in clean kerosine and then dry. When dry, shake and tap the base on to a clean surface ensuring all residual debris is freed from between the element folds.

(4) Remove all debris from filter papers and examine (Ref. Debris Acceptance Standards).

NOTE: Passing a magnet covered with tissue paper over the filtered contents will effectively extract any magnetic material.

(5) Ensure element is dry following debris recovery
R (Ref. para.(3)).

(6) Cut through filter element adjacent to both end fittings, remove and discard end fittings.

(7) Inspect element for carbon deposits by examining inner surface using a light and a X5 magnification glass. If significant carbon deposits are found,
R complete filter inspection procedure (Ref. para.(8)) then fit replacement filter element and carry out Test 17, (Ref. 71-00-00, Adjustment/Test).

(8) Inspect filter element for magnetic fines contamination.

(a) Remove and discard element end fittings
R (Ref. para.(6)).

(b) Open out filter element and place on clean work surface.

(c) Cut a section of filter element approx. 6in. x 6in. (150 mm. x 150 mm.) from the centre area, taking care to avoid any contamination of the section by metallic debris generated during cutting.

(d) Carefully remove the wiremesh backing from both sides of the section.

(e) Cut a small specimen piece of element approx. 0.25in. x 0.75in. (6 mm. x 18 mm.) from the centre of the removed section.

(f) Hold one end of the specimen piece and place a magnetic chip detector probe head near the opposite end. If any magnetic attraction is evident it is indicative of contamination by fine metallic particles, this can be generated by cage lapping or skidding damage to a bearing within the engine and the source must be
R investigated as detailed in para (9) through
R (14).

(9) Take 0.5 Imp.pt (0.5 U.S. pt, 0.75 Litre) sample of oil from engine.

(10) Send oil sample and remaining section of filter element for laboratory analysis with instructions to check specifically for the presence of ADQ (18%W, 4%Cr, 1%V) bearing material.

(11) Inspect MCD's as detailed in Table 1 and 2.

(12) If MCD inspection is satisfactory the engine may be released for a maximum of 25 flying hours pending the result of laboratory analysis.

(13) If laboratory analysis facilities are not available the engine must be scheduled for removal within 25 flying hours.

(14) If laboratory analysis of the oil sample or filter element reveals the presence of ADQ (18%W, 4%Cr, 1%V) bearing material the engine must be removed.

D. Scavenge (Engines without S.B.72-7654), and Pressure Pump (Oil Tank) Gauze Strainers

(1) Remove scavenge and oil tank gauze strainers (Ref.72-01-00, Removal/Installation).

(2) Collect drained oil in clean receptacles; use separate receptacles for each strainer.

(3) Strain drained oil through a filter paper.

(4) Inspect collected debris under a bright light using a glass of approximately X5 magnification.

(5) Wash strainer elements and covers in clean kerosine to remove any particles.

(6) Strain kerosine through filter paper ensuring no particles remain in receptacle.

(7) Pass a magnet covered with tissue paper over collected debris on filter paper to separate ferrous particles.

(8) Inspect ferrous and non-ferrous collected debris as in para.(4) above.

(9) Install strainers (Ref.72-01-00, Removal/Installation).

3. Debris Identification

A. Magnetic Chip Detectors

(1) MCD debris can be divided into 4 main categories: Swarf (ref. fig.601), Fines (ref. fig.602), Flakes (ref. fig.603) and Chips (ref. fig.604).

(2) Any ferrous (magnetic) debris which cannot be readily identified should be submitted for laboratory analysis.

B. Filter and Strainers

(1) Filters and strainers may contain both magnetic and non-magnetic debris. Refer to fig.601, 602, 603 and 604 for identification of magnetic debris.

(2) Non-magnetic debris may consist of magnesium, aluminium, silver, bronze, carbon or rubber sealing ring particles.

(3) Any non-magnetic debris that cannot readily be identified should be returned to MCIEE for analysis. C

4. Debris Acceptance Standards

A. Fine scavenge and pressure filter contents

(1) The following acceptance standards apply to either filter.

(a) Small amounts of light alloy (aluminium) or silver are acceptable.

(b) Coarse particles or chips of steel or bronze are unacceptable.

(c) Flakes of steel or bronze are unacceptable.

(d) Small amounts of fine magnetic particles are usually apparent even in serviceable engines. As a guide, experience indicates that the amount should not exceed that which would thinly cover a 0.5inch sided square. Amounts in excess of this are unacceptable.

(e) Machining debris left in the engine inadvertently during manufacture (swarf) is acceptable.

(f) Chips of steel which can be positively identified as gear tooth corners not exceeding 5mm x 5mm x 5mm are acceptable. The defective gearshaft should be replaced at next shop visit.

R (g) A total of up to 3 bearing cage rivet heads in the
R filters, strainers and on the M.C.D's is acceptable.

R (h) Four or more rivet heads in the filters, stainers
R and on the M.C.D's - Schedule engine removal within
R 125 hours or 25 flights whichever is sooner.

B. Magnetic chip detectors

(1) Small amounts of fine magnetic particles forming fur or dust around the magnet or hair like slivers of steel, are not necessarily indicative of engine failure, particularly if running time is low since new, repair or overhaul. Experience shows that the amount of this type of debris should not exceed that which will lightly cover half MCD circumference. For accumulations in excess of this amount, follow MCD inspection procedure (Ref. Table 1 and 2).

(2) Machining debris left in the engine inadvertently during manufacture (swarf) is acceptable.

R (3) A total of up to 3 bearing cage rivet heads in the
R filters, strainers and on the M.C.D's is acceptable.

R (4) Four or more rivet heads in the filters, stainers
R and on the M.C.D's - Schedule engine removal within
R 125 hours or 25 flights whichever is sooner.

(5) If flakes or chips are found, proceed with MCD inspection procedure (Ref. Table 1 and 2) to determine engine serviceability.

C. Scavenge and pressure pump (oil tank) gauze strainers.

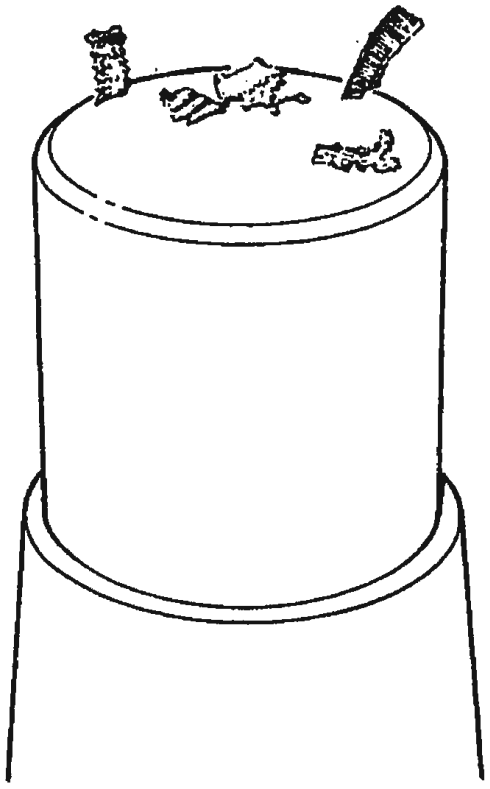
(1) Isolated particles of aluminium, magnesium or small shreds of seal ring or general swarf are acceptable.

(2) Coarse particles of steel or bronze are unacceptable.

R (3) A total of up to 3 bearing cage rivet heads in the
R filters, strainers and on the M.C.D's is acceptable.

R (4) Four or more rivet heads in the filters, stainers
R and on the M.C.D's - Schedule engine removal within
R 125 hours or 25 flights whichever is sooner.

**SWARF**
This is machining debris—inadvertently left in the engine during build. Pieces of turning are easily identifiable but milling debris, when broken up, could possibly be confused with gear or steel seal rubbings and must be carefully examined.



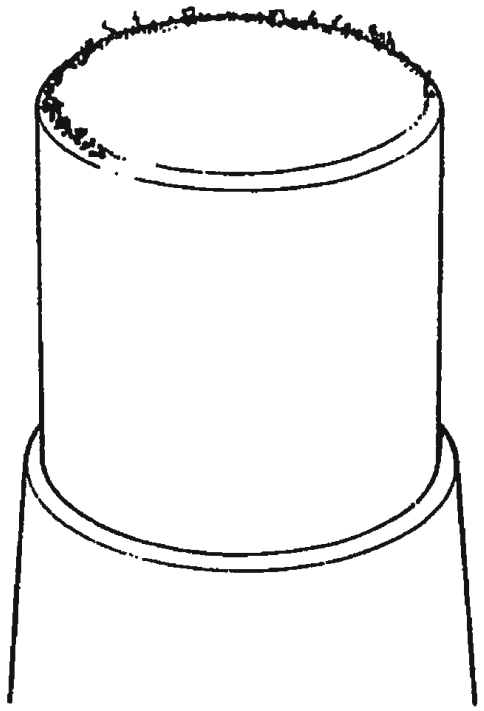
A2933

R Swarf
R (Approximate magnification X10)
R Fig.601

MAGNETIC FINES

Fines appear on an oily MCD as a black sludge. These result from 'normal' engine wear but after being degreased they can, with the naked eye, be mistaken for metallic flakes.

Skidding of a bearing also produces quantities of fines but, after 'normal' wear has been determined by systematic analysis, the occurrence of skidding will be noticed.



A2934

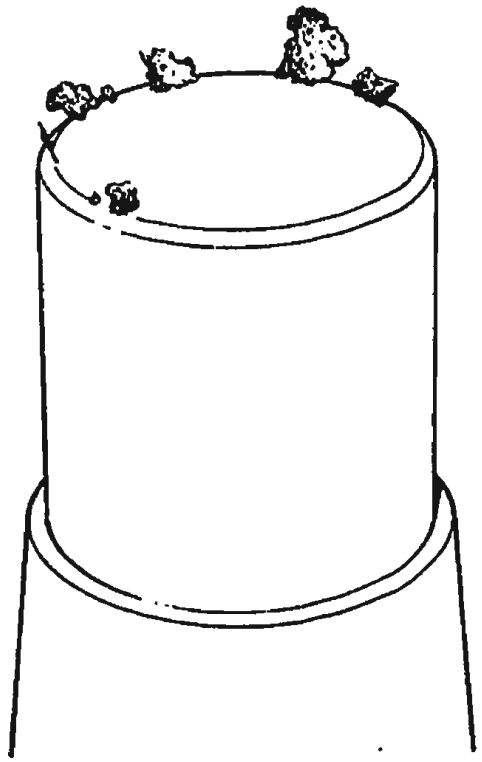
R Fines
R (Approximate magnification X10)
R Fig.602

METALLIC FLAKES
These can be sub-divided into ball bearing, roller bearing, bearing track and gear teeth flakes.

(1) Ball bearing and ball bearing track flakes are usually roughly circular with radial splits.

(2) Roller bearing and roller bearing track flakes are roughly rectangular in shape with criss-cross scratches.

(3) Gear teeth flakes, resulting from scuffing, are of irregular shape and have lustrous appearance.



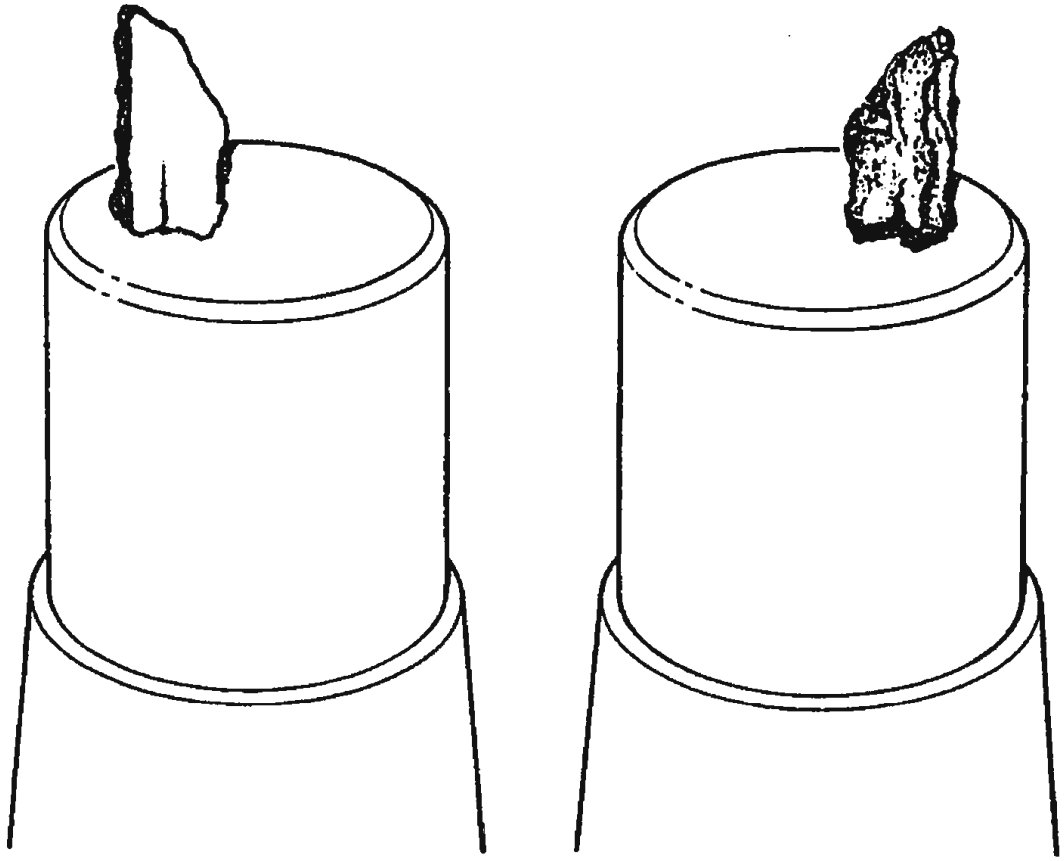
A2935

R Flakes
R (Approximate magnification X10)
R Fig.603

CHIPS AND GEAR TEETH FRAGMENTS

Chips—these are very thick flakes or definite lumps of metal usually with one ground (smooth) surface.

Gear teeth fragments—corner pieces of gear teeth may be evidence of incorrect gear alignment or bedding.



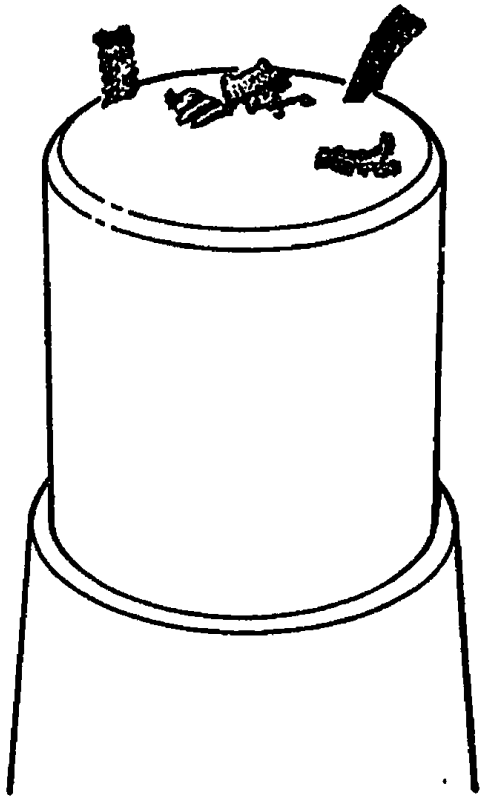
A2936

R
R
R

Chips
(Approximate magnification X10)
Fig.604

**SWARF**
This is machining debris—inadvertently left in the engine during build. Pieces of turning are easily identifiable but milling debris, when broken up, could possibly be confused with gear or steel seal rubbings and must be carefully examined.

Fig 601 is also reproduced in MCD Photographic Supplement, 72-01-00, Appendix-1



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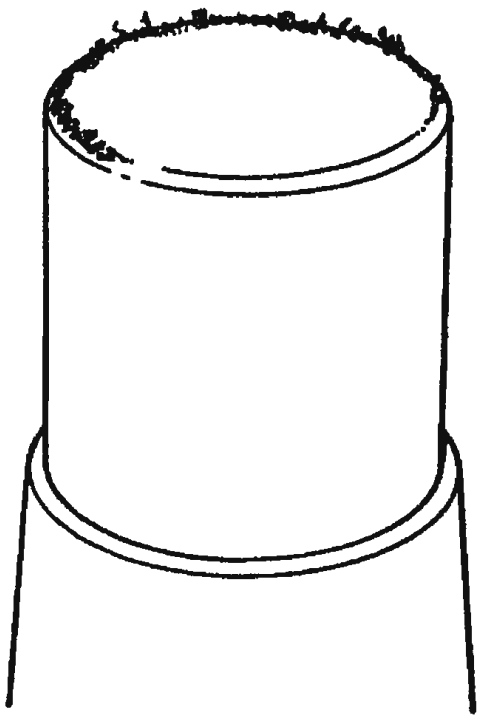
Swarf
(Approximate magnification X10)
Fig.601

**MAGNETIC FINES**

Fines appear on an oily MCD as a black sludge. These result from 'normal' engine wear but after being degreased they can, with the naked eye, be mistaken for metallic flakes.

Skidding of a bearing also produces quantities of fines but, after 'normal' wear has been determined by systematic analysis, the occurrence of skidding will be noticed.

Fig 602 is also reproduced in MCD Photographic Supplement, 72-01-00, Appendix-1



68498

Fines
(Approximate magnification X10)
Fig.602

METALLIC FLAKES

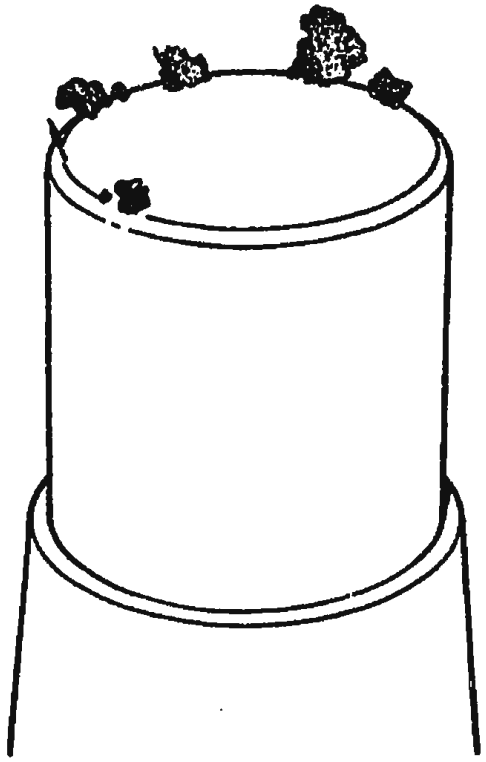
These can be sub-divided into ball bearing, roller bearing, bearing track and gear teeth flakes.

(1) Ball bearing and ball bearing track flakes are usually roughly circular with radial splits.

(2) Roller bearing and roller bearing track flakes are roughly rectangular in shape with criss-cross scratches.

(3) Gear teeth flakes, resulting from scuffing, are of irregular shape and have lustrous appearance.

Fig 603 is also reproduced in MCD Photographic Supplement, 72-01-00, Appendix-1



68497

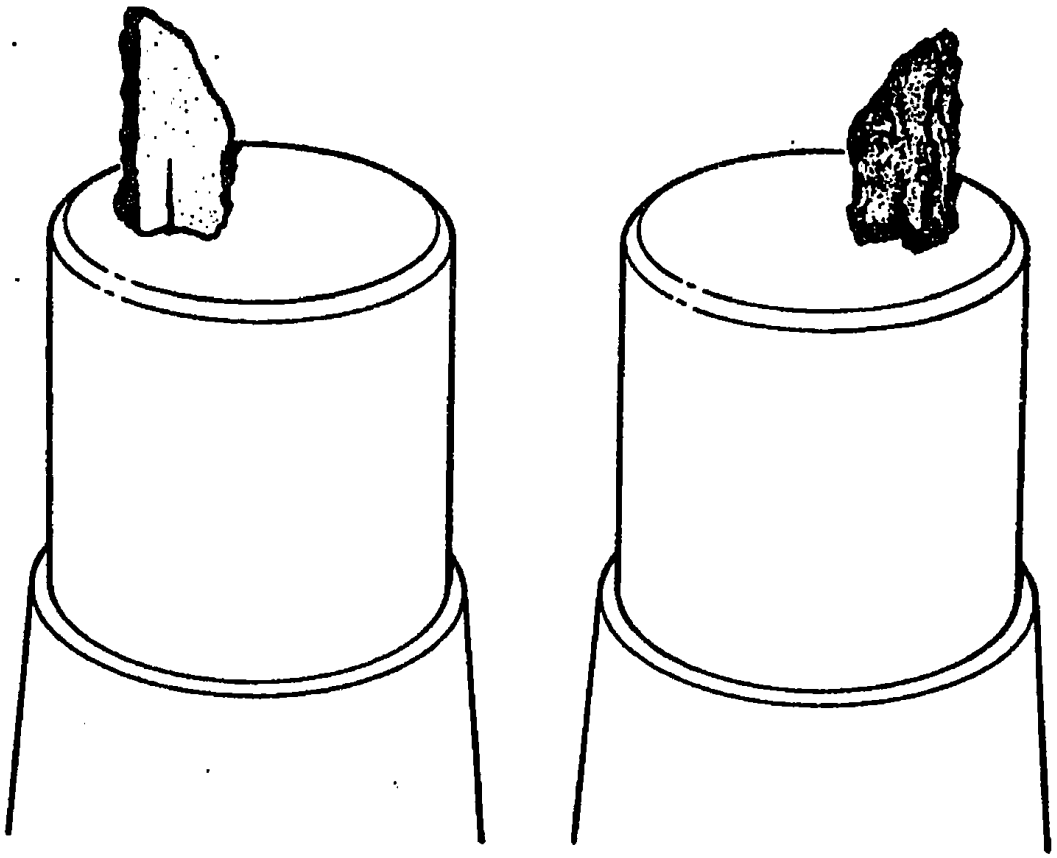
Flakes
(Approximate magnification X10)
Fig.603

**CHIPS AND GEAR TEETH FRAGMENTS**

Chips—these are very thick flakes or definite lumps of metal usually with one ground (smooth) surface.

Gear teeth fragments—corner pieces of gear teeth may be evidence of incorrect gear alignment or bedding.

Fig 604 is also reproduced in MCD Photographic Supplement, 72-01-00, Appendix-1



68498

Chips
(Approximate magnification X10)
Fig.604

# OIL SYSTEM - CLEANING/PAINTING

R **WARNING:** 1. THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE MAY CAUSE SKIN IRRITATION IF SKIN CONTACT IS REPEATED OR PROLONGED.

R 2. IMMEDIATELY AFTER SHUTDOWN ENGINE OIL TEMPERATURE
R REMAINS HIGH, THEREFORE EXTREME CARE MUST BE OBSERVED
R WHEN WORKING NEAR TO, OR ON, ENGINE OIL SYSTEM
R COMPONENTS AND TUBES.

**CAUTION:** 1. THE OIL SPECIFIED FOR USE IN THIS OIL SYSTEM IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS OF THE ENGINE NOT NORMALLY IN CONTACT WITH IT. ANY OIL SPILT DURING SERVICING MUST BE WIPED UP IMMEDIATELY.

2. CONTAMINATION BY MINUTE AMOUNTS OF CERTAIN ALKALINE CLEANING FLUIDS CAN CAUSE COMPLETE BREAKDOWN OF THE SYNTHETIC OIL. USE SCRUPULOUSLY CLEAN CONTAINERS AND EQUIPMENT.

3. DRAINED OIL MUST NOT BE RETURNED TO THE SYSTEM.

The procedures described in this section are listed below.


| Paragraph | Procedure |
|---|---|
| 1. | General |
| 2. | Engine Oil System Contamination Checks |
| 3. | Clean Carbon Deposits from Fine Scavenge Filter Element and/or Pressure Filter Element |
| R 4. | Preservation of Main Line Bearings |

## 1. General

A. This chapter details the procedures required in the event of engine oil system becoming contaminated by fuel, hydraulic fluids, non-approved synthetic engine oils and mineral oil.

B. The acceptable level of contamination by volume is as follows:

| | |
|---|---|
| Fuel-aviation kerosene and diesel | 0.5% |
| Hydraulic fluid - mineral and phosphate | 0.3% |
| Non-approved synthetic engine oil | 10.0% |
| Mineral oil | 2.0% |

CR Samples of oil contaminated by any other fluids should be sent to MCI Power Plant Maintenance Engineering for laboratory analysis and assessment of effect on engine operation.

C. All instances of contamination, giving both type and degree together with subsequent findings, should be reported as
CR soon as possible to Power Plant Maintenance Engineering.

D. Source of contamination should be identified and necessary action taken to prevent recurrence.

E. If oil analysis facilities are not immediately available the following procedures can be performed:

(1) If engine has not run, nor been dry motored since contaminant has been introduced, then continued
CR operation is permissible, provided that procedures
CR contained in para.2.A.(1),(2),(3) have been carried out.

(2) If engine has run, or been dry motored since contaminant has been introduced, then continued
CR operation is permissible pending the result of samples
CR taken, provided that procedures contained in
CR para.2.B.(1),(2),(3),(4) have been carried out.

Referenced Procedures:

| | |
|---|---|
| 12-12-01 | Engine Oil Replenishment |
| 71-00-00 | Power Plant - Adjustment/Test |
| 72-01-00 | Oil System - Servicing and Removal/Installation |
| 72-62-00 | Accessory Section - Servicing |

Illustrated Parts Catalogue References

The I.P.C. sections where parts, disturbed during the following operations, can be located are as follows:-

| | |
|---|---|
| 72-01-03 | Scavenge Oil Filter |
| 72-63-00 | H.S. External Gearbox |

2. Engine Oil System Contamination Checks

A. Oil system contamination - engine has not run or been dry motored since contaminant was introduced.

CR (1) Drain engine oil. Take oil sample of approximately 0.5 CR U.S. pints (0.5 imp. pints, 0.3 litres) for analysis.

CR (2) No action is required except to replenish oil tank with CR new approved engine oil.

CR (3) Replenish oil tank with new approved engine oil (Ref. 12-12-01).

B. Oil System Contamination - engine has run or been dry motored since contaminant was introduced.

(1) Take oil sample of approximately 0.5 U.S. pints (0.5 Imp. pints) (0.3 litres) for analysis.
CR Send to MCI Power Plant Maintenance Engineering.

CR (2) If analysis indicates greater than or it is suspected CR to be greater than the acceptable level of contamination CR stated in para.1.B., drain oil system (Ref.72-01-00). CR Accomplish Test 17 Ref.71-00-00.

CR (3) Replenish oil tank with new approved engine oil (Ref.12-12-01).

CR (4) After next flight, accomplish M11-79-01. Advise MCIMD to CR schedule check.

## 3. Clean Carbon Deposits from Fine Scavenge Filter Element and/or Pressure Filter Element

A. Equipment required:

Moisture-free compressed air supply
Compressed air/water blast
Ultrasonic cleaning facility

B. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Cold solvent decarboniser | DF.1450 | MIL-C-19853 -A | 178 |
| Degreasing fluid (Inhibited and stabilized 1.1.1 trichloroethane) | BS.4487: 1969 | MIL-T-81533 | 1/21 |
| Clean kerosine | | | |
| Wetting agent | Synperonic 'N' | - | 2/7 |

C. Clean element (Engines without S.B.72-4889)

(1) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Immerse element in degreasing fluid, slowly agitate element in fluid then remove and allow to dry.

(2) Clean element, using ultrasonic cleaning bath containing cold solvent decarboniser.

If ultrasonic cleaning facility not available, place element in cold solvent decarboniser for 90 to 120 minutes then remove and wash in cold water.

(3) Using an air/water blast thoroughly clean external surface of element using sufficient pressure to remove carbon without damaging the element.

(4) Immerse element in boiling water for 1 minute then remove and dry with moisture free compressed air.

(5) Carry out a further element inspection using light and magnifying glass (Ref. 72-01-00, Inspection/Check).

(a) If element is clean, reassemble and refit element (Ref. 72-01-00, Removal/Installation).

(b) If element is still contaminated repeat operation 3.C.

D. Clean element (Engines with S.B.72-4889)

(1) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.

Immerse element in degreasing fluid, slowly agitate and remove element from fluid. Immerse element in clean degreasing fluid then remove and allow to dry.

NOTE: Thorough degreasing will result in more effective cleaning of the element. This will be achieved if the degreasing operation is conducted in an ultrasonic bath. Vapour degreasing will not effectively degrease the element and must not be used.

(2) Immerse element in the inverted position in an ultrasonic bath containing 1% Synperonic 'N' wetting agent in water at 80 degrees C. operate the ultrasonic bath at 25-50 kHz for 15 to 20 minutes and remove element. If this frequency is not obtainable 13 KHz will be adequate.

NOTE: To facilitate this operation the element can be placed in a container of 1% Synperonic 'N' wetting agent in water at 80 degrees C. and the container placed in an ultrasonic bath containing clean hot water and a few drops of wetting agent.

(3) Wash element in hot running water, ensuring element is back flushed. If hot water is not available, cold water will be adequate.

(4) Remove element and dry with moisture free compressed air.

(5) Place element against a background of light and visually inspect the element.

NOTE: Particular attention should be made to the bottom of the element pleats.

(a) If element is clean, refit (Ref. 72-01-00, Removal/Installation).

(b) If element is still contaminated repeat operation 3.D.

4. Preservation of Main Line Bearings

It is recommended that the following procedure should be accomplished before the engine is removed from the aircraft providing the engine can be motored without damage, by the starter motor. If the engine is to be motored after removal from the aircraft, it must be installed in multi-purpose stand CP.30000/7 or equivalent heavy-duty stand.

A. Drain engine oil tank (Ref. 72-01-00).

B. Replenish engine oil tank with 2.0 Imperial gallons (2.40 U.S. gallons, 9.10 Litres) of clean approved oil (Ref. 12-12-01).

C. Dry motor engine (Ref. 71-00-00) until oil pressure is indicated on flight station indicator. If motoring cycle is liable to exceed starter operating limitations (Ref. 71-00-00) before oil pressure is indicated, terminate motoring cycle. Confirm oil quantity in engine oil tank is sufficient then effect another dry motoring cycle.

## OIL TUBES AND FITTINGS - REMOVAL/INSTALLATION

R WARNING: 1. THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE MAY
R CAUSE IRRITATION IF SKIN CONTACT IS REPEATED OR PROLONGED

2. IMMEDIATELY AFTER SHUTDOWN ENGINE OIL TEMPERATURE REMAINS HIGH. THEREFORE, EXTREME CARE MUST BE OBSERVED WHEN WORKING NEAR TO OR ON ENGINE OIL SYSTEM COMPONENTS AND TUBES.

CAUTION: 1. THE OIL SPECIFIED FOR USE IN THE OIL SYSTEM IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS OF THE ENGINE NOT NORMALLY IN CONTACT WITH IT. ANY OIL SPILT DURING SERVICING MUST BE WIPED UP IMMEDIATELY.

2. CONTAMINATION BY MINUTE AMOUNTS OF CERTAIN ALKALINE CLEANING FLUIDS CAN CAUSE COMPLETE BREAKDOWN OF THE SYNTHETIC OIL. USE SCRUPULOUSLY CLEAN CONTAINERS AND EQUIPMENT.

3. DRAINED OIL MUST NOT BE RETURNED TO THE SYSTEM.

R Referenced Procedures:

R 70-12-02 - Fitting Vee Band Coupling Clamps
R 70-51-00 - Torque Tightening Techniques

1. Remove Oil Tubes (General)

CAUTION: WHEN WITHDRAWING TUBE FROM CONNECTORS, CARE MUST BE TAKEN TO AVOID DAMAGING TUBE.

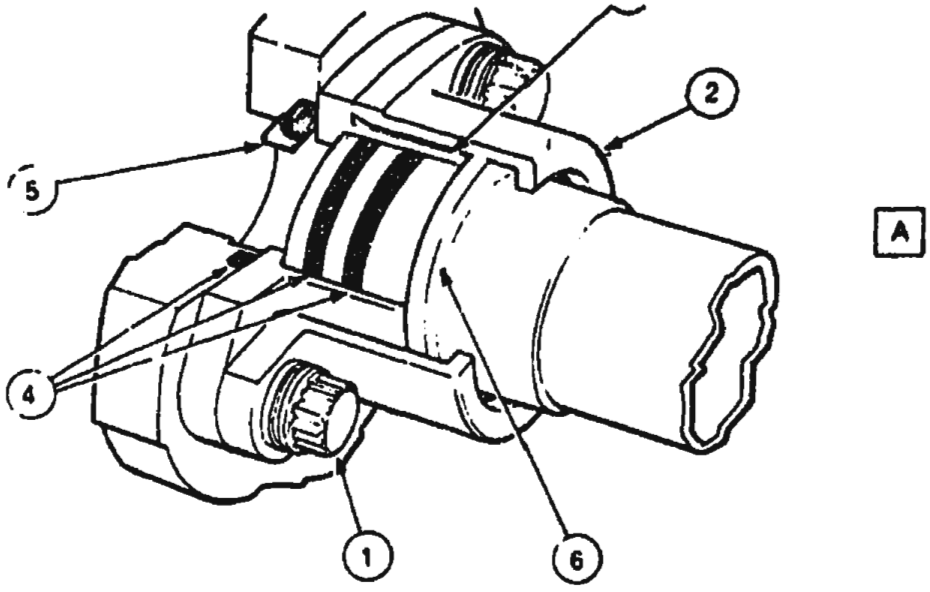
A. Remove tube support clips.

B. Remove tube connector assembly (Ref.A. Fig.401).

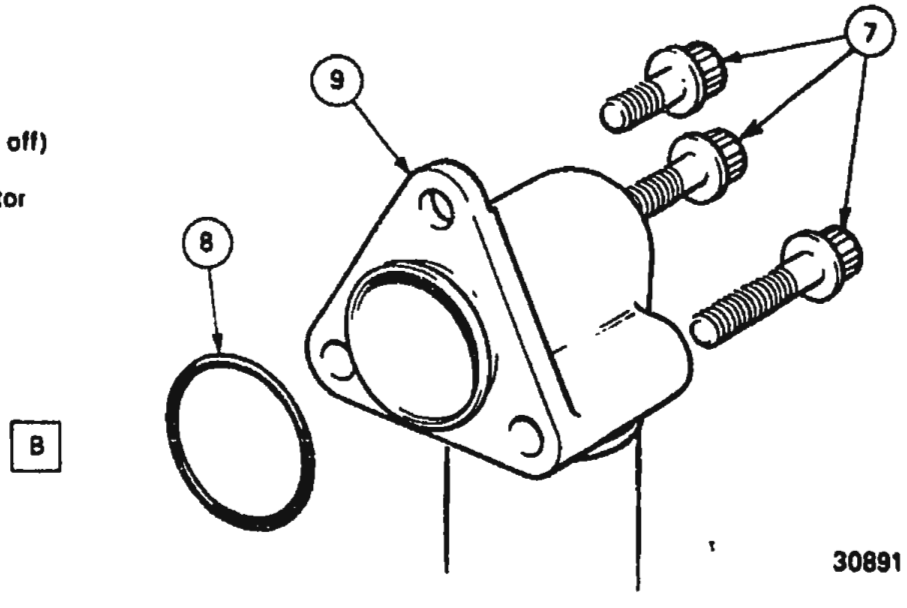
(1) Remove bolts (1) and remove tube.

(2) Slide retainer (2) along tube and remove connector (3).

(3) Discard all disturbed seal rings.




1. Securing bolts
2. Retainer
3. Connector
4. Seal rings
5. Seal ring retainer
6. Tube collar
7. Retaining bolts (3 off)
8. Seal ring
9. Fixed end connector




R Typical oil connectors
R Fig.401

C. Remove tubes incorporating fixed end connectors. (Ref.B. Fig.401).

(1) Remove bolts (7) and remove tube.

(2) Discard all disturbed seal rings (8).

D. Remove tubes incorporating union nut connectors.

(1) Disconnect union nut and remove tube.

E. Fit approved blanks to all exposed apertures and connectors.

2. Install Oil Tubes (General)

CAUTION: TUBES PUSH EASILY INTO CONNECTORS; RETAINING PLATES OR RETAINERS MUST NOT BE USED TO FORCE HOME TIGHT-FITTING TUBES; IF DIFFICULTY IS EXPERIENCED, THE CAUSE MUST BE TRACED AND RECTIFIED

A. Remove blanks, if fitted, from apertures and connectors.

B. Ensure mating faces, connector bores and tube ends are clean and free from damage.

C. Fit and lubricate (Ref.70-12-02) new seal rings to relevant grooves on tube ends, connectors and/or units, and around seal retaining rings as appropriate.

D. Fit tubes with connector assembly (Ref.A. fig.401)

(1) Slide connector (3) over seal rings until it abuts tube collar (6).

(2) Slide retainer (2) over connector (3).

(3) CAUTION: ENSURE POSITIVE RETENTION OF CONNECTOR ASSEMBLIES 'A' BY CHECKING POSITION OF RETAINER (2) PRIOR TO EFFECTING THE FOLLOWING OPERATION.

Fit tube in position on engine and secure the bolts (1), interposing locking plates, brackets or clips as detailed in relevant unit installation procedure.

E. Fit tubes incorporating fixed end connectors. (Ref.B. fig.401).

(1) Fit tube in position on engine and secure with bolts (7).

F. Fit tubes incorporating union nut connectors.

(1) Fit tube in position on engine and secure with union nut. Torque tighten union nuts (Ref.70-51-00 para.10), and lock.

G. Fit tube support clips as applicable.

3. Removal/Installation of Oil Tubes (8), (23) and (24) (Ref.72-01-00, Description and Operation, fig.8).

A. Equipment required:

| | |
|---|---|
| UT.855/1 | Spanner wrench |
| UT.856/1 | Spanner wrench |
| UT.923 | Spanner wrench |

B. When connecting tube (8) at services disconnect platform, use tool UT.855/1. Torque tighten union (Ref.70-51-00, para.10), and wirelock.

C. When connecting tube (23) at services disconnect platform, use tool UT.856/1. Torque tighten union (Ref.70-51-00, para.10), and wirelock.

D. When connecting tube (24) at services disconnect platform, use tool UT.923. Torque tighten union (Ref.70-51-00, para 10), and wirelock.

R # OIL TUBES AND FITTINGS - INSPECTION/CHECK

R WARNING: 1. THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE MAY CAUSE SKIN IRRITATION IF SKIN CONTACT IS REPEATED OR PROLONGED.

R 2. IMMEDIATELY AFTER SHUT DOWN ENGINE OIL TEMPERATURE REMAINS HIGH. THEREFORE EXTREME CARE MUST BE OBSERVED WHEN WORKING NEAR TO OR ON ENGINE OIL SYSTEM COMPONENTS AND TUBES.

R CAUTION: 1. THE OIL SPECIFIED FOR USE IN THIS OIL SYSTEM IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS OF THE ENGINE NOT NORMALLY IN CONTACT WITH IT. ANY OIL SPILT DURING SERVICING MUST BE WIPED UP IMMEDIATELY.

R 2. CONTAMINATION BY MINUTE AMOUNTS OF CERTAIN ALKALINE CLEANING FLUIDS CAN CAUSE COMPLETE BREAKDOWN OF THE SYNTHETIC OIL. USE SCRUPULOUSLY CLEAN CONTAINERS AND EQUIPMENT.

R 3. DRAINED OIL MUST NOT BE RETURNED TO THE SYSTEM.

R Referenced Procedures

R 12-12-01 Engine oil Replenishment
R 72-01-00 Oil System - Removal/Installation

R 1. Inspect Oil Tubes

R A. Inspection

R (1) Inspect oil tubes for dents, nicks, fretting and scoring.

R B. Acceptance Standards for Feed Oil Tubes

R (1) Dents - Smooth dents of a large area relative to depth and which do not reduce the diameter of the tube by more than 10 per cent at any one point, providing they are not within one diameter or 0.500 in. (12.7 mm.) whichever is the greater, of the tube end fitting.

R Smooth dents of small area up to 0.125 sq.in. (0,806 sq.mm.) providing they are round bottomed and their depth does not exceed 0.015in. (0,381 mm.) on the outside surface of a bend, 0.025in. (0,635 mm.) on remaining sections of the tube and also providing they are not within one diameter or 0.500in. (12,7 mm.) whichever is the greater, of the tube end fitting.

R (2) Nicks - Nicks that are round bottomed and do not exceed 0.004in. (0,102 mm.) in depth providing they are not on the outside surface of a bend and all burrs are removed.

R (3) Fretting - Fretting up to a maximum depth of 0.004in. (0,102 mm.)

R (4) Scoring - Light scoring can be blended out providing not more than 0.004in. (0,102 mm.) of metal is removed.

R C. Acceptance Standards for Return Oil Tubes

R (1) Dents - As B. (1).

R (2) Nicks - As B. (2).

R (3) Fretting - Fretting up to a maximum depth of 0.007in. (0,178 mm.) on the outside surface of a bend and 0.010in. (0,254 mm.) on remaining sections of the tube.

R (4) Scoring - As B. (4).

R 2. Check Oil Acidity

R A. Obtain Oil Sample

R (1) Equipment required:

R Clean, glass receptacle - minimum capacity

R 0.5 Imperial pints
R 0.5 U.S. pints
R 0.3 Litres

R (2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Lockwire | DTD.189A 22 S.W.G. | - 21 A.W.G. | 238 |

R (3) Release blanking nut positioned to right of drain plug on fine scavenge filter, refer to 72-01-00, Removal/Installation, and slacken sufficiently to allow approximately 0.25 Imperial pints (0.25 U.S. pints, 0.15 litres) of oil to drain.

R (4) Secure blanking nut and wirelock.

R (5) Replenish oil system (Ref.12-12-01) and record accurately in U.S. pints the amount of 'top-up' oil required.

R (6) Retain small sample of top-up oil for use in para.B. (1).

R B. Calculate Oil Acidity

R (1) Determine the total acid number of the used oil sample
R and of the top-up oil in accordance with IP.1/64
R Method A, or ASTM-D 974-IP.139 except, that in both
R procedures the sample and the top-up oil shall be
R titrated cold with aqueous standard alkali.

R (2) Calculate the observed acidity increase by subtracting
R the total acid number of the top-up oil from that of
R the used oil.

R (3) Calculate the corrected acidity increase using the
R following equation:

R Corrected acidity increase = Observed acidity increase

R $$\times \left(1 - \frac{\text{top-up oil (U.S. pt.)}}{140}\right) \text{ mg.KOH/g.}$$

R (4) The maximum permitted corrected acidity increase is
R 1.00 mg.KOH/g.

# COOLING AND SEALING AIR SYSTEM - DESCRIPTION AND OPERATION

## 1. General

The engine (zones 412, 422 and 432) is internally cooled by air taken from the engine compressors. The air is also used to prevent internal leakage of oil and gas.

The internal temperature of the engine is monitored by an overheat indicating system (Ref. 77-22-00) which senses the cooling air temperature through sampling tubes fitted in the
R turbine area. The sampled air is also sensed by the aircraft
R intergrated data system (A.I.D.S.).

A simplified diagram of the I.P. and H.P. cooling and sealing air flow is shown in fig.1 and the air flows through the engine are illustrated in fig.3. Fig.2 illustrates types of air and oil seals used in the engine.

## 2. Description

### A. L.P. Compressor Air

L.P. compressor delivery air is used to cool the L.P. compressor disc as illustrated in fig.3.

L.P. compressor delivery air flows inwards between the L.P. compressor disc and the L.P. compressor disc sealing plate to cool the rear of the disc. The air then passes through the L.P. compressor curvic coupling into the spinner where it cools the front of the L.P. compressor disc and exhausts through a gap between the spinner and the L.P. compressor into the air intake.

### B. I.P. Compressor Air

I.P. compressor air for cooling and sealing is taken from the 4th (I.P.4) and 7th (I.P.7) stages of I.P. compressor as illustrated in fig.1 and 3.

Stage 4 I.P. Air

Some of the I.P.4 air pressurizes the front bearing housing seals, to prevent oil leaking from this area, and then passes through a series of air restrictors and exhausts into the I.P. compressor intake.

The remainder of the I.P.4 air passes through a series of holes to the inside of the L.P. compressor shaft and the fail safe shaft assembly. Some of this air flows forward to anti-ice the L.P. compressor spinner (Ref. 75-11-00) and some rearward to pressurize the L.P. turbine bearing housing seals. The rearward flowing air also cools the rear face of the 2nd stage and the front and rear faces of the 3rd stage of the L.P. turbine and prevents the inward flow of hot gas by exhausting into the hot gas stream between the turbine blade roots and the nozzle guide vanes.

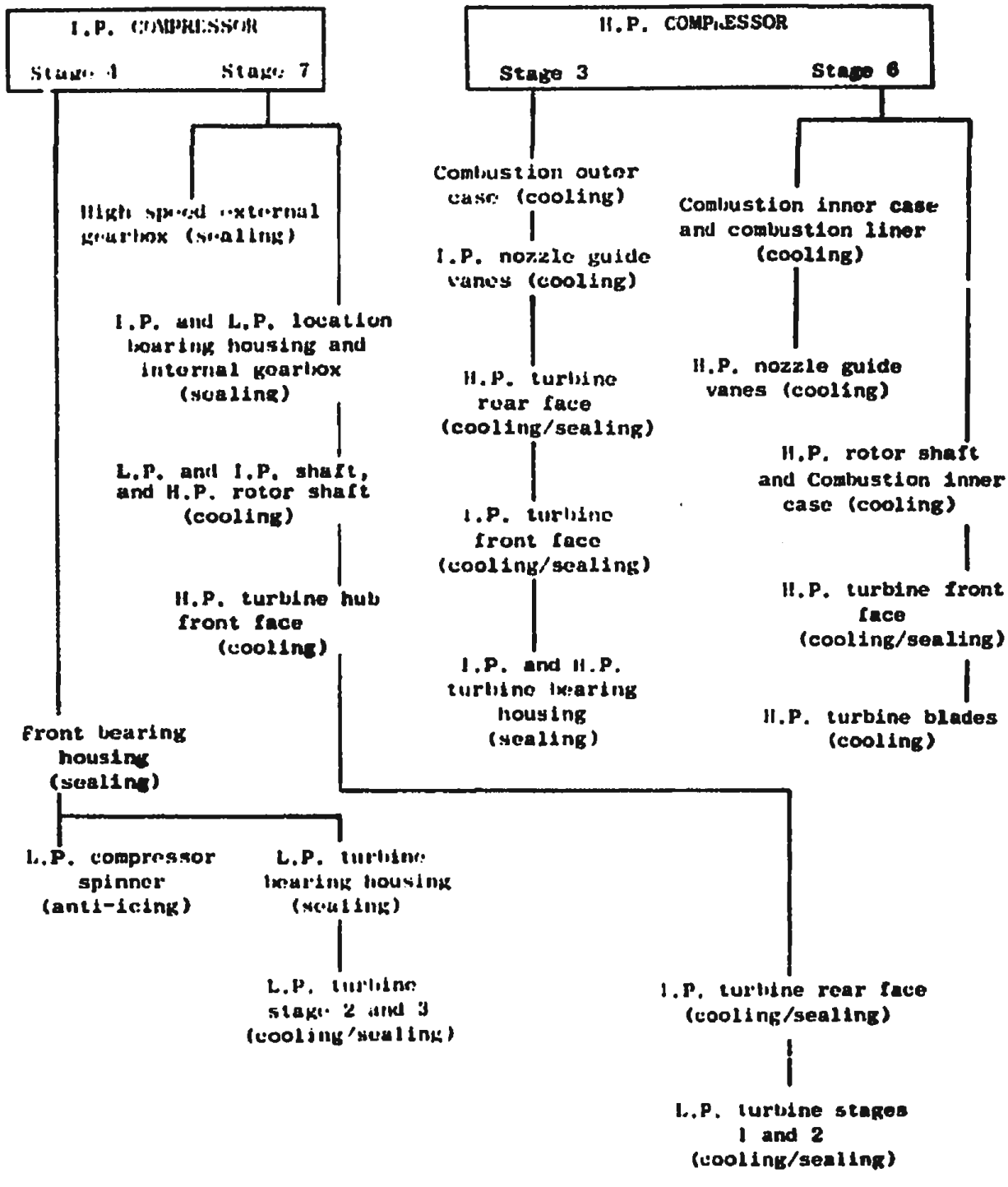
Stage 7 I.P. Air

I.P.7 air is used to pressurize the L.P. and I.P. location bearing housing seals and the internal gearbox seals. The air also flows rearwards, cooling the I.P. shaft, the H.P. rotor shaft and the hub of the H.P. turbine disc, and passes through holes in the I.P. shaft to mix with 3rd stage H.P. compressor air. This air then flows between the I.P. and L.P. shafts into the area between the rear face of the I.P. turbine and the front face of the 2nd stage L.P. turbine. The air cools the turbine discs and prevents the inward flow of hot gas by exhausting into the gas stream between the turbine blade roots and the nozzle guide vanes.

I.P.7 air is also used to seal the accessory driveshafts in the high-speed external gearbox.

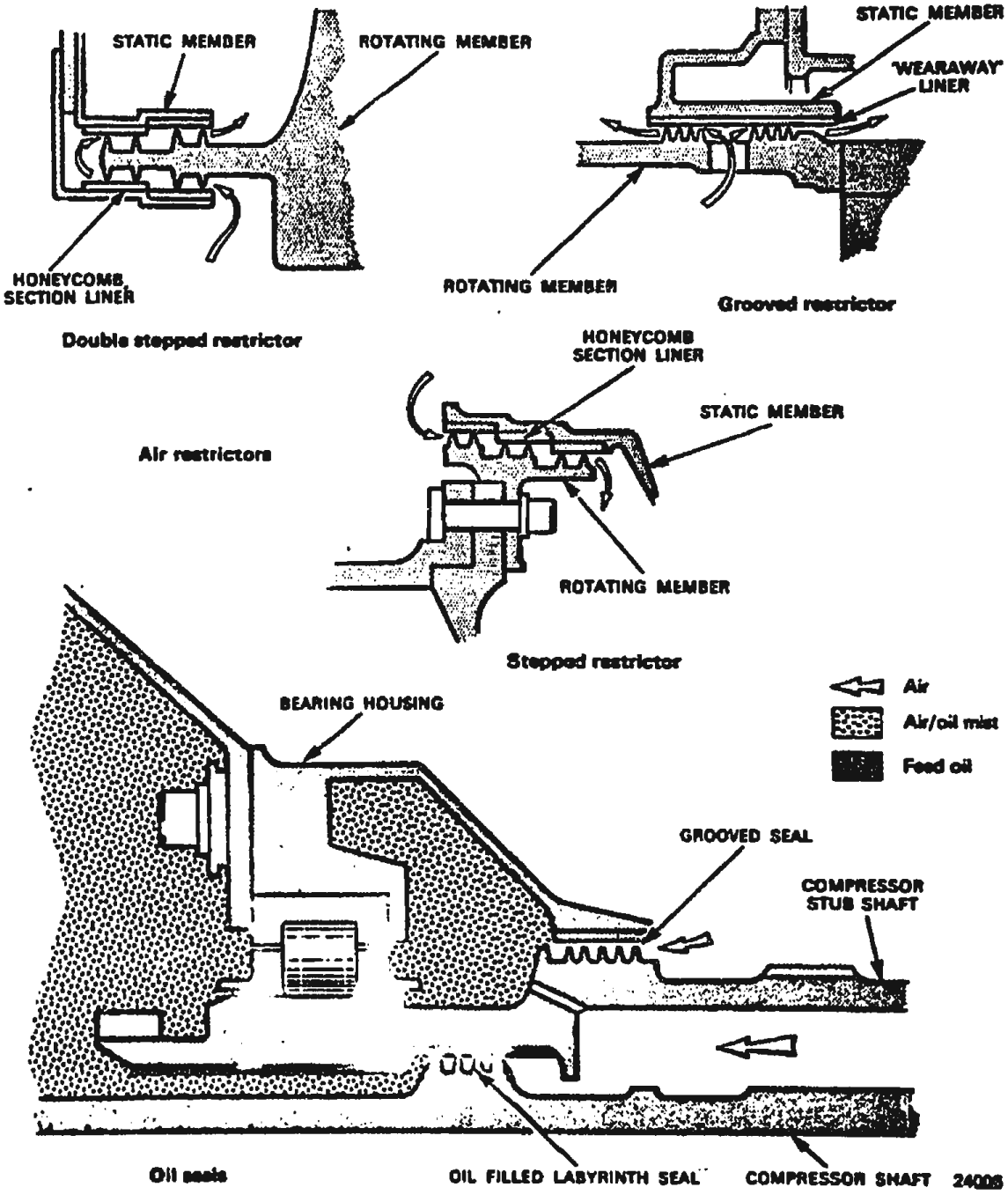
R The air is fed through an external tube to a manifold tube, incorporating six bosses, secured to the outside of the gearbox. The bosses connect with internal gearbox drillings that direct the air to the air starter, the integrated drive generator and the hydraulic pumps driveshaft seals and also to the centrifugal breather.

R Engines with S.B.72-4202 have an air cleaner in the
R external tube.


I.P. COMPRESSOR
Stage 4
Stage 7
H.P. COMPRESSOR
Stage 3
Stage 6
High speed external gearbox (sealing)
I.P. and L.P. location bearing housing and internal gearbox (sealing)
L.P. and I.P. shaft, and H.P. rotor shaft (cooling)
H.P. turbine hub front face (cooling)
Front bearing housing (sealing)
L.P. compressor spinner (anti-icing)
L.P. turbine bearing housing (sealing)
L.P. turbine stage 2 and 3 (cooling/sealing)
Combustion outer case (cooling)
I.P. nozzle guide vanes (cooling)
H.P. turbine rear face (cooling/sealing)
I.P. turbine front face (cooling/sealing)
I.P. and H.P. turbine bearing housing (sealing)
Combustion inner case and combustion liner (cooling)
H.P. nozzle guide vanes (cooling)
H.P. rotor shaft and Combustion inner case (cooling)
H.P. turbine front face (cooling/sealing)
H.P. turbine blades (cooling)
I.P. turbine rear face (cooling/sealing)
L.P. turbine stages 1 and 2 (cooling/sealing)

30041

I.P. and H.P. cooling and sealing air flow simplified diagram
Fig.1




Typical air restrictors and oil seals
Fig.2

Some of the air prevents oil escaping from the gearbox by passing along the driveshafts into the gearbox from where it exhausts through the centrifugal breather. The remainder of the air prevents oil or hydraulic fluid entering the gearbox by passing along the driveshafts into the accessory mounting flange chambers from where it exhausts through the non-fuel drains system (Ref. 71-70-00).

C. High Pressure Compressor Air

H.P. compressor air for cooling and sealing is taken from the 3rd (H.P.3) and 6th (H.P.6) stages of the H.P. compressor as illustrated in fig.1 and 3.

Stage 3 H.P. Air

H.P.3 air passes rearward between the combustion inner and outer cases into the I.P. nozzle guide vanes. As the air flows through the nozzle guide vanes a portion is allowed to pass through holes in the inner sleeve to cool the inside of the vanes and then exhaust into the gas stream through slots in the trailing edges. The remainder of the H.P.3 air flows through holes in the H.P. and I.P. rear bearing housing support to cool the front face of the I.P. turbine disc and the rear face of the H.P. turbine disc. Some of the air exhausts into the gas stream between the L.P. nozzle guide vanes and the H.P. and I.P. turbine blade roots to prevent the inward flow of hot gas. The remainder of the air passes around the H.P. and I.P. rear bearing housing through a series of air restrictors and then passes through holes in the I.P. shaft to mix with I.P.7 air.

Stage 6 H.P. Air

H.P.6 air flows rearwards, cooling the H.P. rotor shaft and the inner combustion case, to the front face of the H.P. turbine disc. The air then flows outwards, cooling the disc, and passes through pre-swirl nozzles into the H.P. turbine blade roots. The air passes upwards, cooling the inside of the blades and exhausts into the gas stream through slots in the sides and the outer platforms of the blades.

H.P.6 air also flows rearwards to cool the combustion liner and the inner combustion case. This air is then used to cool the H.P. nozzle guide vanes by passing the air through the vanes and allowing it to exhaust into the gas stream through slots in the trailing edges and the sides of the vanes.

D. Air Restrictors and Oil Seals

Air Restrictors

Air restrictors, of the types illustrated in fig.2, are positioned through the engine to ensure the cooling and sealing air system satisfies the following functions:

Effective turbine disc cooling by controlling the rate of air flow across disc faces.

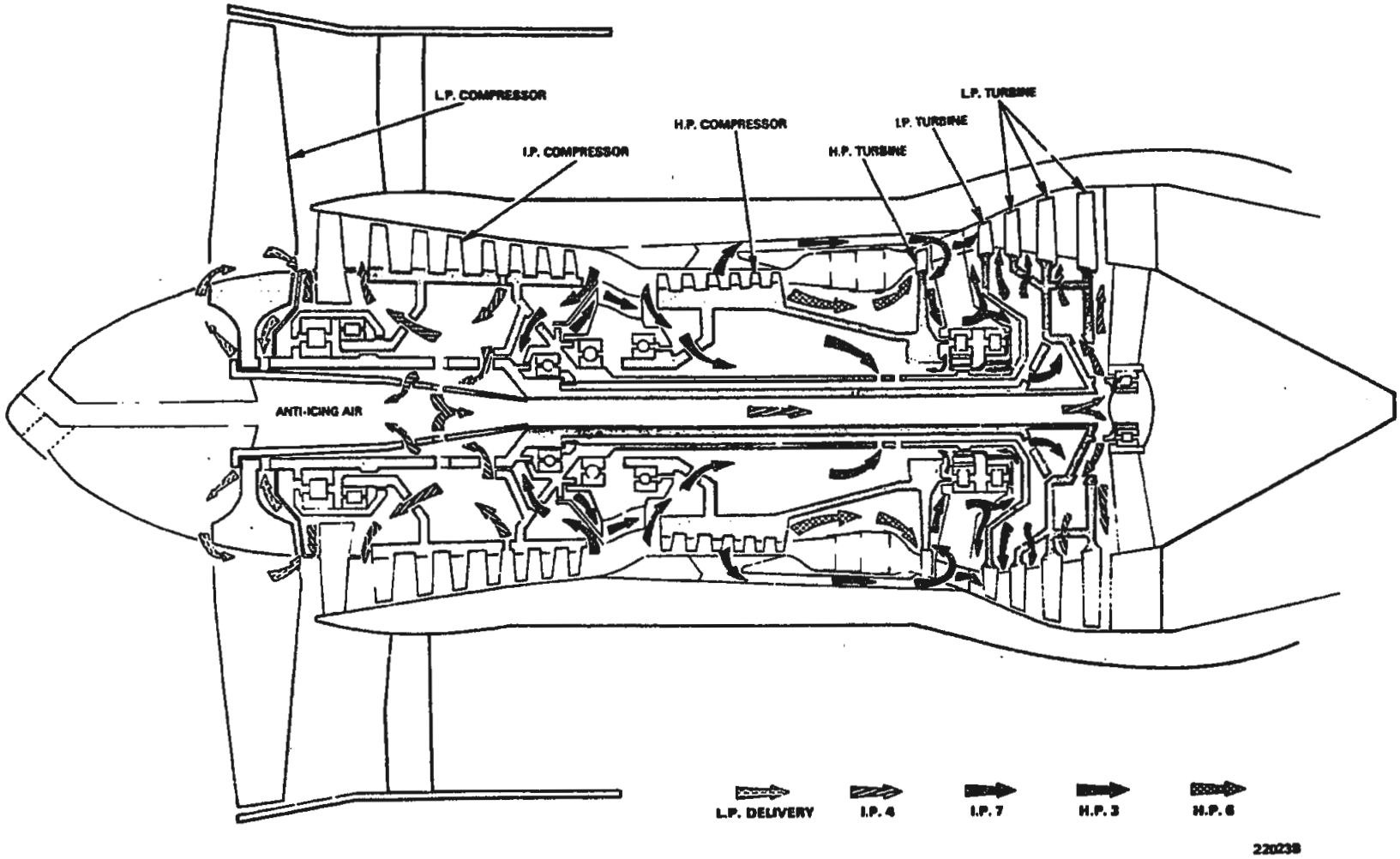
Prevention of inward flow of hot gas into the engine by proportioning the discharge of air between the turbine blades and the nozzle guide vanes.

Prevention of air leakage between stages of compression.

Oil Seals

Grooved type, air pressurized oil seals, consisting of a static and a rotating member, are fitted to the engine to prevent oil leakage from the bearing housings and the internal gearbox. To prevent leakage between two rotating components, oil filled labyrinth seals are used individually or in conjunction with a ring seal. A typical grooved seal and an oil filled labyrinth seal are illustrated in fig.2.

The oil filled labyrinth seal consists of a conventional finned inner member, integral with the compressor shaft, rotating in an annulus formed on the inner face of the stub shaft. Bearing feed oil, sprayed between the compressor shaft and the stub shaft, is thrown against the inner face of the stub shaft by centrifugal force as shown in fig.2. The tips of the fins, running in the oil thrown into the annulus, form a seal that prevents oil leaving or air entering the bearing housing.




Cooling and sealing air flow
Fig.3

R COOLING_AND_SEALING_AIR_TUBES_-_REMOVAL/INSTALLATION

R 1. Removal/Installation_-_Centrisep_Air_Cleaner

R Referenced Procedures:

R 70-51-00 Torque tighten Technique.
R 72-03-00 Gas Generator Fairings - Remova/Installation.
R 78-30-00 Thrust Reverser - Servicing.

R Illustrated Parts Catalogue References:

R The I.P. section where parts disturbed during the following
R operations can be located are:

R 72-02-01 Cooling and Sealing Air System.
R 72-03-00 Gas Generator Fairings.

R A. Remove Centrisep Air Cleaner

R (1) Equipment required:

R 289200 or C4G4342 Protective work mats

R (2) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN
R FORWARD THRUST POSITION WHILE WORK IS IN
R PROGRESS.
R Deactivate and tag thrust reverser and associated
R systems and fit thrust reverser locks (Ref. 78-30-00).

R (3) Position protective work mats in cold stream duct.

R (4) Remove compressor section lower fairing (72-03-00).

R (5) Refer fig.401 remove nut and bolt (1) and leave
R support clip on tube.

R (6) Loosen connector (2).

R (7) Remove nuts and bolts securing flange connector (3)
R and bolts at flange connector (4), then remove tube
R (5) leaving bracket attached to tube support clips.

R (8) Disconnect connector (2) and remove centrisep cleaner
R (6).

R (9) Fit blanks to all exposed apertures and connectors.

R B. Install Centrisep Air Cleaner

R (1) Materials required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Lockwire | DTD.189A 22 S.W.G. | - 21 A.W.G. | 238 |

R (2) Ensure thrust reverser is locked, and associated systems
R deactivated and tagged as detailed in operation 1.A.(2).

R (3) Remove blanks from all apertures and connectors.

R (4) Position centrisep cleaner (6) and loosely assemble
R connector (2).

R (5) Position tube (5) with new gasket and support bracket
R at flange connector (4) and secure with bolts.

R (6) Align holes in centrisep cleaner flange connector
R with holes in flange connector (3) and secure with
R bolts and nuts.

R NOTE: One bolt hole in centrisep flange connector
R is off-set.

R (7) Secure (Ref. 70-51-00) connector (2) and wirelock.

R (8) Secure support clip with nut and bolt (1).

R (9) Fit compressor section lower fairing.

R (10) Remove protective work mats from cold stream duct.

R (11) Unlock and reactivate thrust reverser and associated
R systems.

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R Centrisep Air Cleaner - Removal/Installation
R Fig.401

R EFFECTIVITY: ALL
R

# GAS GENERATOR FAIRINGS - DESCRIPTION AND OPERATION

Service Bulletins referred to:

| | |
|---|---|
| S.B.72-2862 | Zone 3 Pressure Relief Door with Modified Latch Mechanism |
| S.B.78-3551 | Introduction of 15 Degree Afterbody |

## 1. General

The gas generator fairings (Ref. fig.1) extend from the rear of the L.P. compressor outlet guide vane inner platforms to the rear of the exhaust transition case, and provide a smooth inner wall to the L.P. compressor outlet duct and nozzle. The fairings are located in zones 410, 420 and 430.

An engine/power plant interservices fairing, mounted above the engine, provides a smooth aerodynamic shape surrounding the aircraft services air off-take ducts, engine rear mount and thrust reverser air motor.

A hoop plate assembly located above the interservices fairing, completes the ring of the 'C' shaped cold stream thrust reverser (Ref. 78-31-00).

Acoustic materials, incorporated in the fairing construction, assist in engine noise reduction.

## 2. Description

### A. Compressor Section Fairing

The compressor section comprises separate fairings that extend from the rear of the L.P. compressor outlet guide vane inner platforms to the combustion outer case front flange. The fairings are secured to support brackets on the compressor case, and to each other through connecting plates. The two upper fairings meet at the engine top centre and are shaped to fit around the pylon nose section fairing. The front and rear side fairings connect to the upper fairings and to two lower fairings that enclose the high speed external gearbox transfer drive shaft. The lower fairings are secured to each other to complete the compressor section fairing.

The fairings have cut-away sections shaped for the L.P. compressor case support structure and the I.P. and H.P. compressor bleed valves. The R.H. front fairing incorporates a pressure relief door for the zone 2 accessory cooling system (Ref. 75-21-00). The door is hinged on its forward edge and retained in position at the the rear by two spring loaded plungers attached to the door and located in a grooved latch block on the fairing. Excess pressure acting on the inside of the door forces the spring loaded plungers out of the groove, allowing the door to spring open. Panels in the R.H. side front and rear fairings provide access to boroscope inspection plugs, and a panel in the R.H. lower compressor fairing provides access to the transfer drive. The access panels are retained by quick release fasteners.

B. Combustion Section Fairing

The combustion section comprises two side and one upper fairing that form an annulus around the combustion outer case and extend rearward from the combustion case front flange to the engine fireseal at the combustion case rear flange. The upper fairing passes under the pylon front fairing and acts as a flame break-out shield. The side fairings are attached to the upper fairing by hooks and to each other by quick release hook latches. Releasing the latches allows the fairings to hinge upwards or be removed to provide access to the fuel spray nozzles, fuel manifold, igniter plugs and boroscope inspection plugs.

The fairings are supported at the front by a fairing support ring, attached to brackets on the combustion outer case, and at the rear by the forward land of the turbine fairing front support ring. Each fairing incorporates a double lip section that locates on the engine fireseal (Ref. 71-30-00) to divide combustion and turbine areas. A seal, attached to the rear edge in the lower arc of the rear compressor fairings, prevents accumulated fuel from draining through the gap between compressor and combustion fairings and flowing over the outer skin. Fuel accumulating in the combustion fairing is removed through the engine drains system (Ref. 71-70-00).

C. Turbine Section Fairing

The turbine section comprises three separate fairings, each of single skin construction, extending rearward from the rear edge of the combustion fairing to the rear of the exhaust transition case.

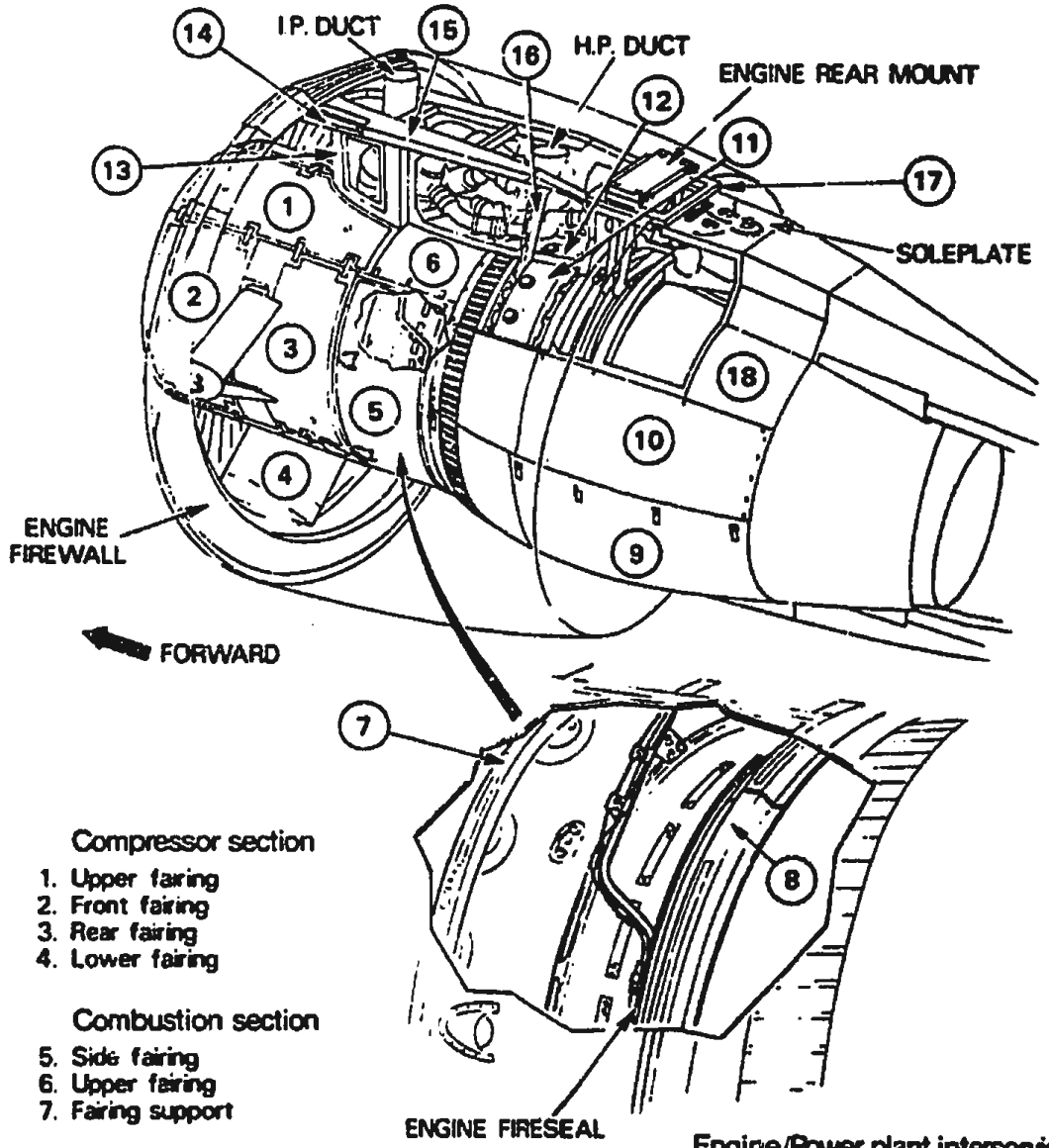
On engines incorporating S.B.78-2969, the side fairings attach to the pylon front and rear fairings with five dog-type connectors that locate in corresponding connectors on the pylon fairings, each pair of connectors being secured by a bolt. Along the lower edge of each side fairing are five 'U' bolts, to which the lower fairing attaches with quick-release hook latches.

On engines incorporating S.B.78-3551, the lower fairing is attached to 4 'U' bolts on each side fairing and secured with quick-release hook latches.

The fairings are secured at the front to a support ring, secured to brackets around the combustion casing, and at the rear to an integral support diaphragm on the exhaust collector case, (Ref. 78-11-00). On engines incorporating S.B.78-3551, the fairings are secured at the rear to the exhaust collector fairing. Seal segments (spring fingers) attached to the front edge of each turbine fairing, together with seal segments integral with the pylon front fairing, form the thrust reverser seal assembly that deflects when contacted by the reverser blocker flaps (Ref. 78-30-00) in reverse thrust configuration.

D. Engine/Power Plant Interservices Fairing

The engine/power plant interservices fairing is mounted at the engine top centre position and surrounds the engine H.P. and I.P. air off-take ducts, engine rear mount and thrust reverser air motor. The fairing is basically a three part structure, comprising a separate nose section, a framework with access panels that together form the pylon front fairing, and a rear pylon fairing that completes the annulus around the exhaust case.




Compressor section
1. Upper fairing
2. Front fairing
3. Rear fairing
4. Lower fairing

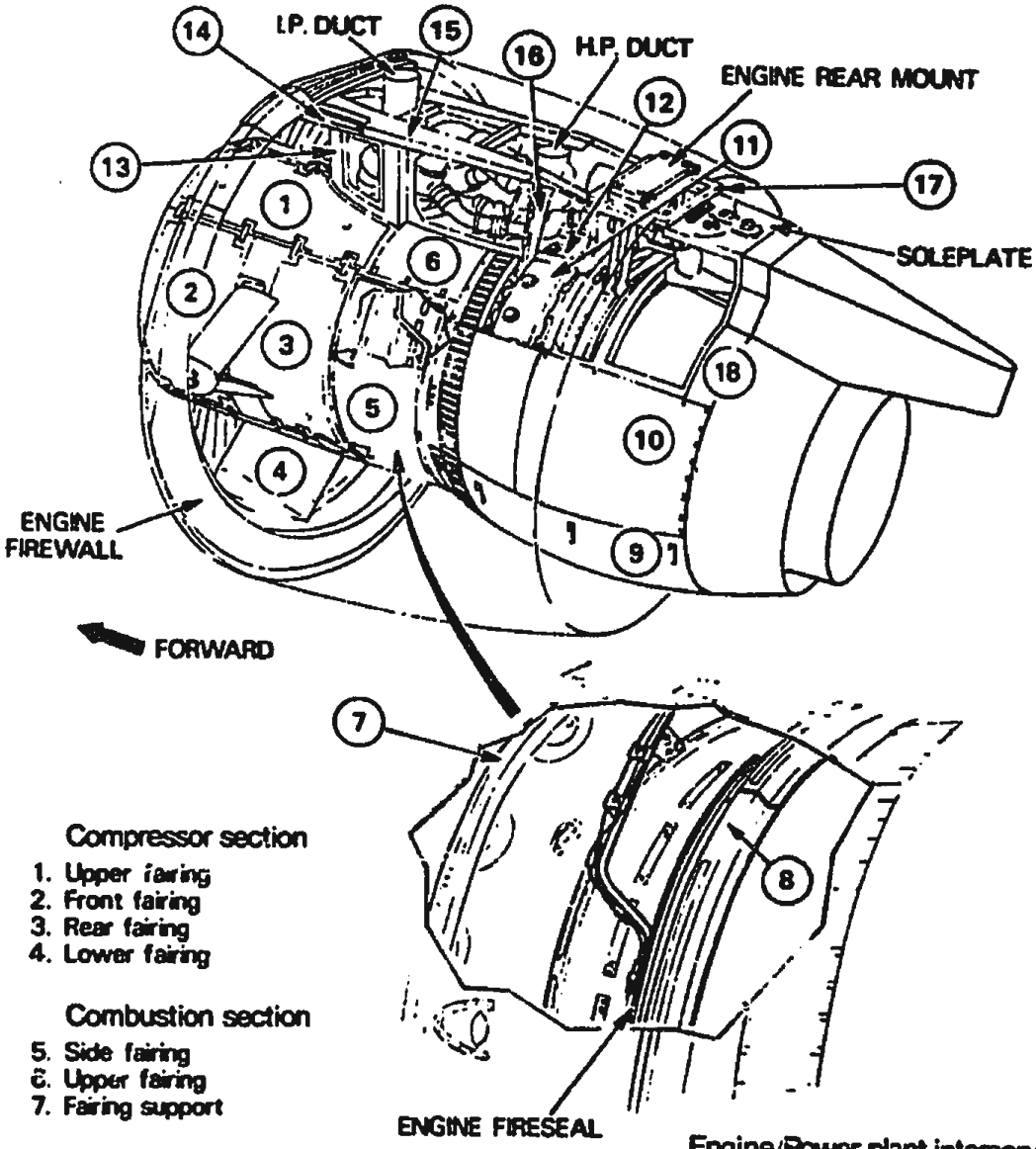
Combustion section
5. Side fairing
6. Upper fairing
7. Fairing support

Turbine section
8. Fairing front support
9. Lower fairing
10. Side fairing
11. I.P/L.P. nozzle box L.H. access panel
12. I.P/L.P. nozzle box centre access panel

Engine/Power plant interservices
13. Pylon nose section fairing
14. Support structure access panel
15. Support structure acoustic fairing
16. Pylon front fairing
17. Hoop plate seal assembly
18. Pylon rear fairing

26131A

Gas generator fairings
Fig.1 (Sheet 1)




Compressor section
1. Upper fairing
2. Front fairing
3. Rear fairing
4. Lower fairing

Combustion section
5. Side fairing
6. Upper fairing
7. Fairing support

Turbine section
8. Fairing front support
9. Lower fairing
10. Side fairing
11. I.P./L.P. nozzle box L.H. access panel
12. I.P./L.P. nozzle box centre access panel

Engine/Power plant interservices
13. Pylon nose section fairing
14. Support structure access panel
15. Support structure acoustic fairing
16. Pylon front fairing
17. Hoop plate seal assembly
18. Pylon rear fairing

34492

Gas generator fairings
(S.B.78-3551)
Fig.1 (Sheet 2)

The pylon front fairing access panels incorporate relief doors through which excess pressure is released in the event of H.P./I.P. bleed duct failure. On engines incorporating S.B.72-2862 the pressure relief door incorporate a modified latch mechanism. These doors should not be opened for servicing unless it is absolutely essential as a reduction in subsequent opening pressure will result. Further removable panels in the floor of the pylon fairings provide access to the I.P./L.P. nozzle box flange.

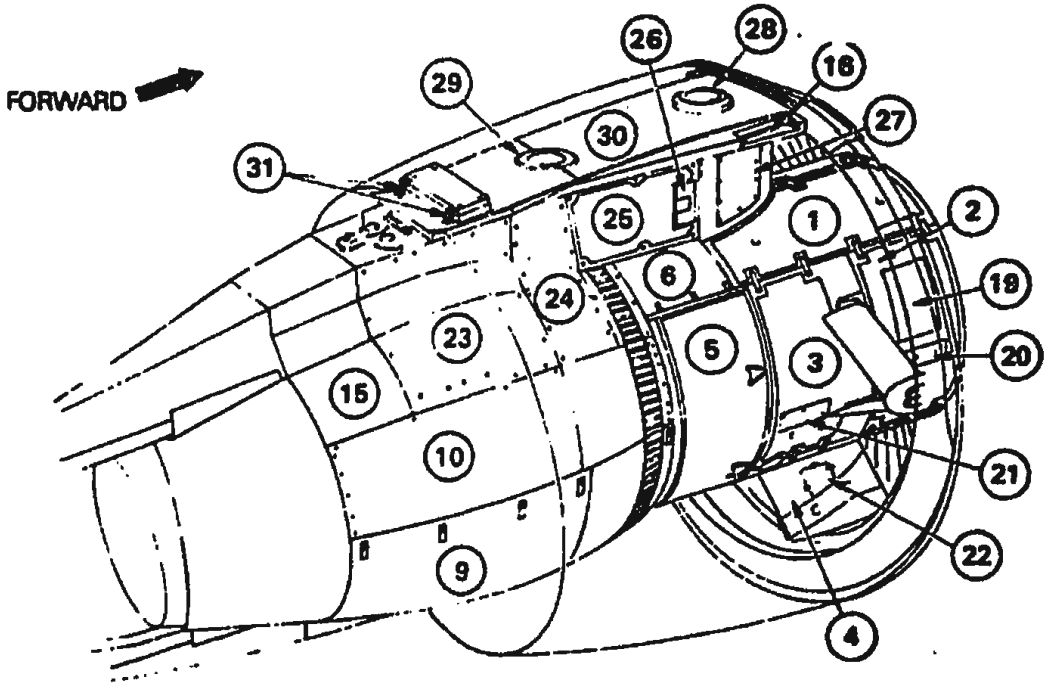
An acoustic fairing support structure is bolted across the top of the interservices fairing, and access panels at front corners of this fairing provide access to the translating cowl flexible drive connectors.

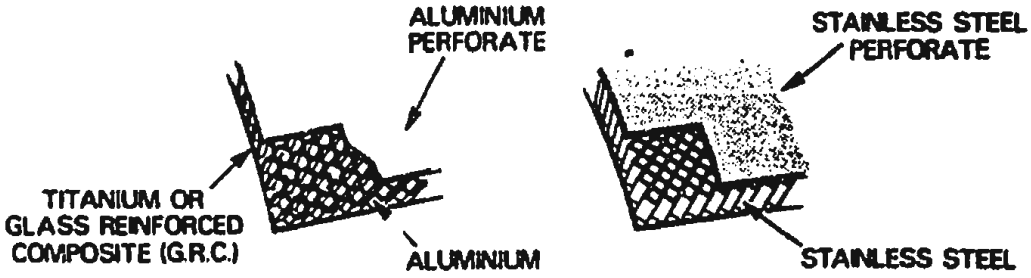
Two sole plates, rivetted to the top of the pylon rear fairing, provide lightening discharge terminals that connect with corresponding airframe terminals. Bonding jumper leads from the terminals, clipped to brackets on the pylon rear fairing, are attached to brackets secured to the transition case rear flange to provide continuity through the fairings to the aircraft. A third soleplate provides attachment for aircraft glove fairing location link (Ref. 54-00-00).

E. Hoop Plate

The hoop plate is located above the interservices fairing to complete the cold stream thrust reverser section and provide location for seal assemblies for H.P. and I.P. off-take ducts at the engine/airframe interface.

The hoop plate is secured longitudinally to the cold stream reverser case (Ref. 78-30-00) and cold stream nozzle, (Ref. 78-12-00) and comprises three separate sections: A front section secured to the engine firewall, an intermediate section extending rearward to the centre line of the H.P. air off-take duct, and a rear section extending to the cold stream nozzle. The I.P. off-take duct passes through the front of the intermediate section, which houses the I.P. duct seal. The rear of the intermediate section has a semi-circular cut-away to accommodate the H.P. air duct and seal assembly. A similar cut-away is provided in the front edge of the rear section hoop plate.




Sandwich construction of fairings

Compressor section

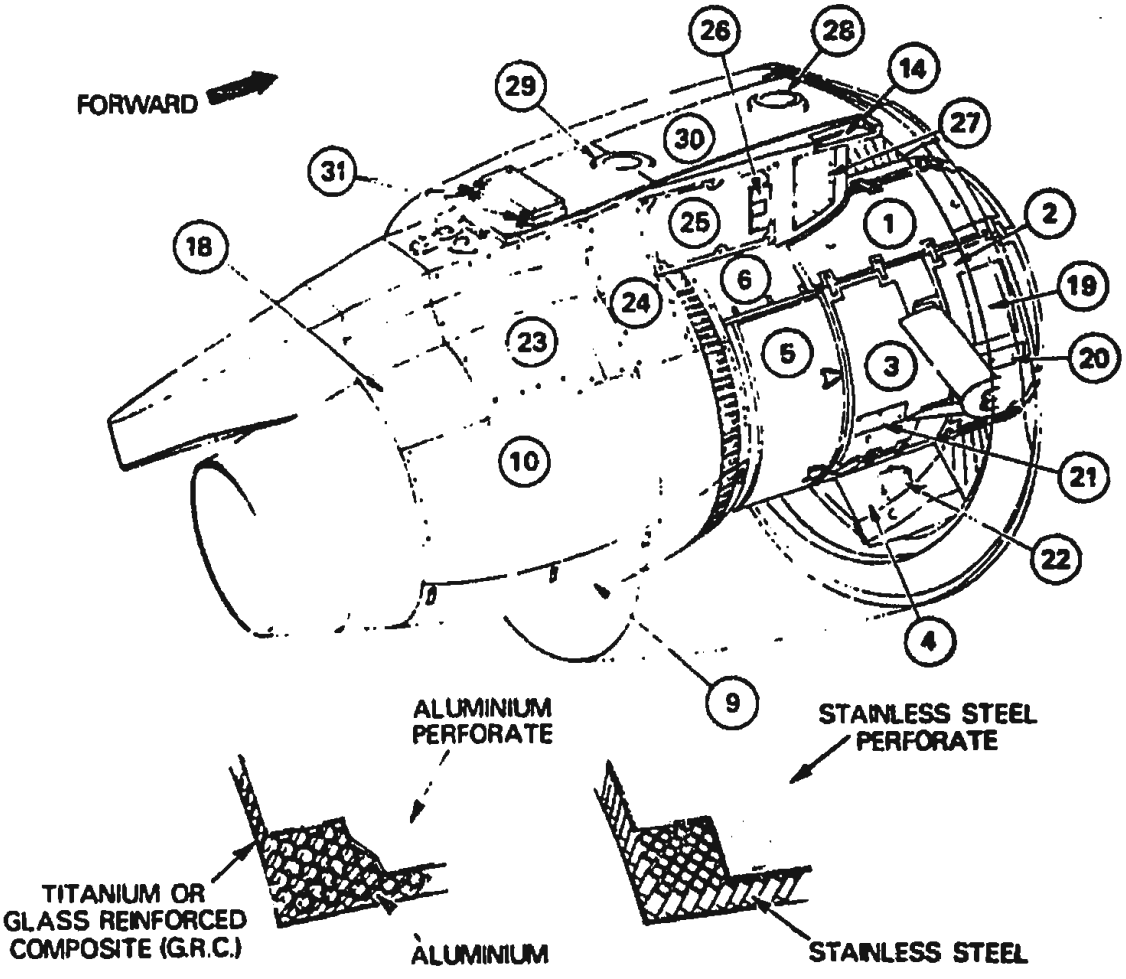
19. Pressure relief door
20. Boroscope access panel
21. Boroscope access panel
22. Lower fairing access panel

Engine/Power plant interservices

23. Pylon rear access panel
24. Interservices access panel
25. Pylon front access panel
26. Pressure blow-out panel
27. Pylon nose access panel
28. I.P. duct seal
29. H.P. duct seal
30. Hoop plate
31. Hoop plate support links

30036

Gas generator fairings
Fig.2 (Sheet 1)




Sandwich construction of fairings

Compressor section

19. Pressure relief door
20. Boroscope access panel
21. Boroscope access panel
22. Lower fairing access panel

Engine/Power plant interservices

23. Pylon rear access panel
24. Interservices access panel
25. Pylon front access panel
26. Pressure blow-out panel
27. Pylon nose access panel
28. I.P. duct seal
29. H.P. duct seal
30. Hoop plate
31. Hoop plate support links

34493

Gas generator fairings
(S.B.78-3551)
Fig.2 (Sheet 2)

The rear section fits around the engine rear mount support bracket and incorporates a seal to provide a fireproof seal between the interservices fairing support structure and the hoop plate. Two brackets secured to the rear section provide attachment for hoop plate adjustable support links, the other ends of which are attached to the rear mount support bracket.

A bracket secured to the H.P. duct seal housing provides attachment for the H.P. air supply duct support cable (Ref. 75-00-00).

F. Noise Suppression

Certain gas generator fairings are constructed of sound absorbing materials to assist in noise suppression throughout the engine.

The compressor section fairings are basically of sandwich construction having an inner core of aluminium honeycomb an an outer skin of perforated aluminium. The upper fairings have an inner skin of titanium while the remainder have an inner skin of glass reinforced composite (G.R.C.).

The combustion section side fairings are of sandwich construction comprising an inner skin and perforated outer skin of stainless steel and an inner core of stainless steel honeycomb.

The pylon front fairing and interservices fairing access panels are of stainless steel sandwich construction with perforated outer skin. The support structure acoustic fairing, is also of sandwich construction, comprising an aluminium inner skin, an aluminium perforate outer skin and an aluminium honeycomb inner core.

The hoop plate noise attenuating features comprise aluminium outer and inner skins with an aluminium honeycomb inner core.

CR

## GAS GENERATOR FAIRINGS - MAINTENANCE PRACTICES

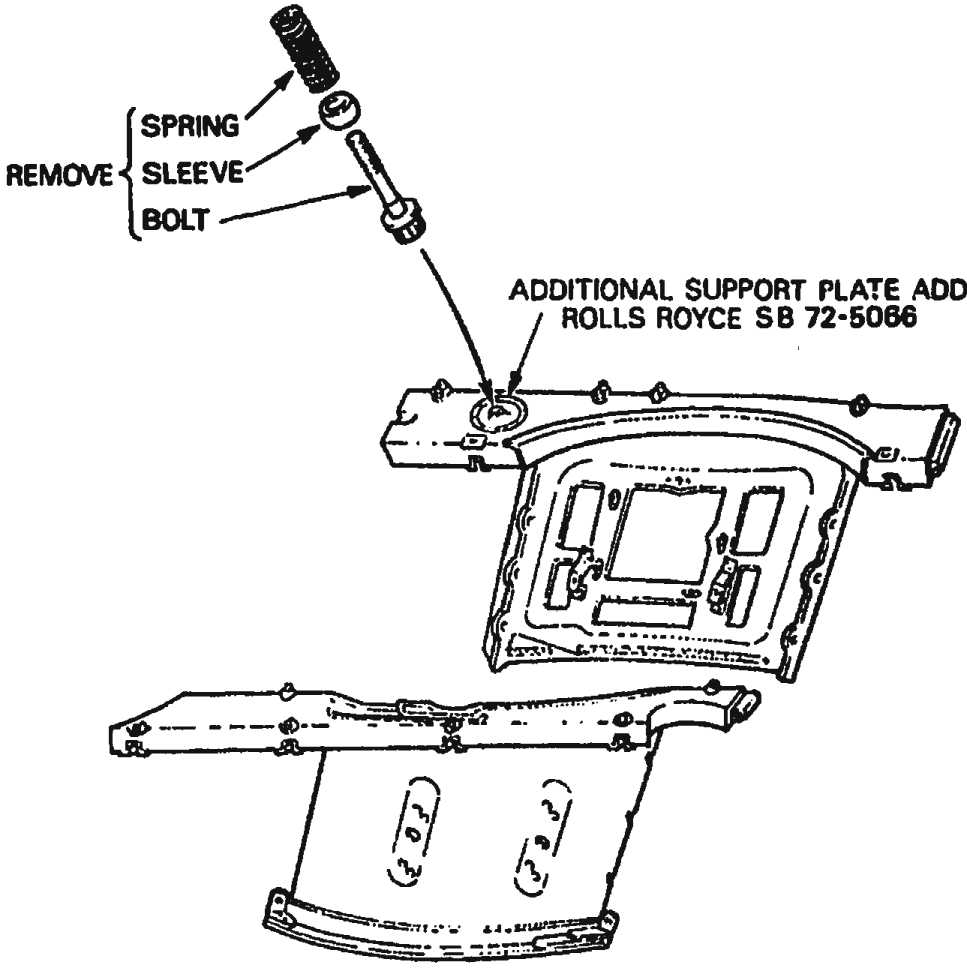
CR 1. RB211 Radial Drive Fairing Configuration

CR A. The later aircraft, as well as any new fairings purchased
CR for spares, incorporate Rolls Royce Service Bulletin 72-5066
CR which adds an additional support plate to the R.H. radial
CR drive fairing and a corresponding attach bracket to the
CR 03 module (intermediate case).

CR B. Handle pre- and post- S/B fairings as interchangeable under
CR the following procedure:

CR (1) Engines which have the additional support bracket
CR installed (located on the front flange of the
CR intermediate case at 6 O-clock) should have post-S/B
CR fairing installed. If a post-S/B fairing is not
CR available, then a pre-S/B standard fairing (one
CR without the additional support plate) may be
CR installed.

CR (2) Engines without the additional support bracket should
CR have pre-S/B fairings installed. If a pre-S/B fairing
CR is not available, then a post-S/B fairing may be
CR installed provided the existing support plate
CR through-bolt, sleeve, and spring are removed.




65214

CR Installation of post-S.B.72-5066 radial drive
CR fairings to pre-S.B. standard engines

R EFFECTIVITY: ALL
R
050B 16

## GAS GENERATOR FAIRINGS - SERVICING

1. Open and close Interservices Fairing Pressure Relief Doors - S.B.72-2862 - Pressure Relief Door With Modified Latch Mechanism

CAUTION: THE PRESSURE RELIEF DOORS SHOULD NOT BE OPENED FOR SERVICING UNLESS IT IS ABSOLUTELY ESSENTIAL TO DO SO. IF ESSENTIAL THE FOLLOWING PROCEDURE MUST BE USED.

A. Open Relief Door

R (1) Equipment required:

R HU21239 Opening Tool

R (2) Using tool HU21239, ease latch head clear of retention
R 'V' in panel frame.

(3) Pull door outward to open.

B. Close Relief Door

(1) Inspect retention 'V' in panel frame for any distortion of the outward face of the 'V'. If distortion apparent change whole panel.

(2) Ensure latch head is in correct angular position in relation to retention 'V'.

(3) CAUTION: DO NOT SLAM THE DOOR CLOSED.
Compress latch spring and carefully close door.

# GAS GENERATOR FAIRINGS - REMOVAL/INSTALLATION

The Removal/Installation procedures described in this section are as follows:


| Paragraph | Procedure |
|---|---|
| 1. | Removal/Installation Turbine Section Fairings |
| A. | Remove turbine section fairings - engines without S.B.78-3551 |
| B. | Remove turbine section fairings - engines with S.B.78-3551 |
| C. | Install turbine section fairings - engines without S.B.78-3551 |
| D. | Install turbine section fairings - engines with S.B.78-3551 |
| 2. | Removal/Installation Combustion Section Fairings |
| A. | Remove combustion section fairings |
| B. | Install combustion section fairings |
| 3. | Removal/Installation Compressor Section Fairings |
| A. | Remove compressor section fairings |
| B. | Install compressor section fairings |
| 4. | Removal/Installation Interservices Access Panels |
| A. | Remove interservices access panels |
| B. | Install interservices access panels |
| 5. | Removal/Installation Compressor Fairings Forward Mounting Brackets |
| A. | Remove fairing mounting brackets |
| B. | Install fairing mounting brackets |
| 6. | Removal/Installation I.P./L.P. Nozzle Box Access Panels |
| A. | Remove I.P./L.P. nozzle box access panels |
| B. | Install I.P./L.P. nozzle box access panels |


## 1. Removal/Installation Turbine Section Fairings

| | |
|---|---|
| Turbine Section Lower Fairing | 417A, 427A and 437A |
| Turbine Section L.H. Fairing | 416BL, 426BL and 436BL |
| Turbine Section R.H. Fairing | 416BR, 426BR and 436BR |

Illustrated Parts Catalogue References:

The I.P.C. sections where parts disturbed during the following operations can be located are as follows:

72-03-03 Turbine Section Gas Generator Fairings

A. Remove Turbine Section Fairings - Engines without S.B.78-3551

CAUTION: THE WEIGHT OF THE TURBINE SECTION LOWER FAIRING IS APPROXIMATELY 76 LB (34,5 KG) AND THAT OF THE L.H. AND R.H. FAIRINGS IS APPROXIMATELY 26 LB (11,8 KG).

(1) Equipment required:

289200 or C 4G 4342 Protective work mats

(2) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems and fit thrust reverser locks (Ref. 78-30-00, Servicing).

(3) Position protective work mats in cold stream duct.

(4) Refer to fig.401 (Sheet 1), support lower fairing (2), release hook latches (3) and remove fairing.

(5) Remove screws (4) from leading and trailing edges of L.H. side fairing (1).

(6) Support L.H. side fairing (1), remove bolts (5) from pylon fairing interface and lift side fairing clear.

(7) Repeat operations (5) and (6) for R.H. side fairing.

(8) Remove protective work mats.

B. Remove Turbine Section Fairings - Engines with S.B.78-3551

CAUTION: THE WEIGHT OF THE TURBINE SECTION LOWER FAIRING IS APPROXIMATELY 44.5 LB. (20,02 KG.) AND THAT OF THE L.H. AND R.H. FAIRINGS IS APPROXIMATELY 32.5 LB. (14,62 KG.)

(1) Equipment required:

289200 or C 4G 4342 Protective work mats

(2) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems and fit thrust reverser locks (Ref. 78-30-00, Servicing).

(3) Position protective work mats in cold stream duct.

(4) Refer to fig.401 (Sheet 2), support lower fairing (1), release hook latches (2) and remove fairing.

(5) Remove screws (4) from leading and trailing edges of L.H. side fairing (3).

(6) Support L.H. side fairing (3), remove bolts (5) from pylon fairing interface and lift side fairing clear.

(7) Repeat operations (5) and (6) for R.H. side fairing.

(8) Remove protective work mats.

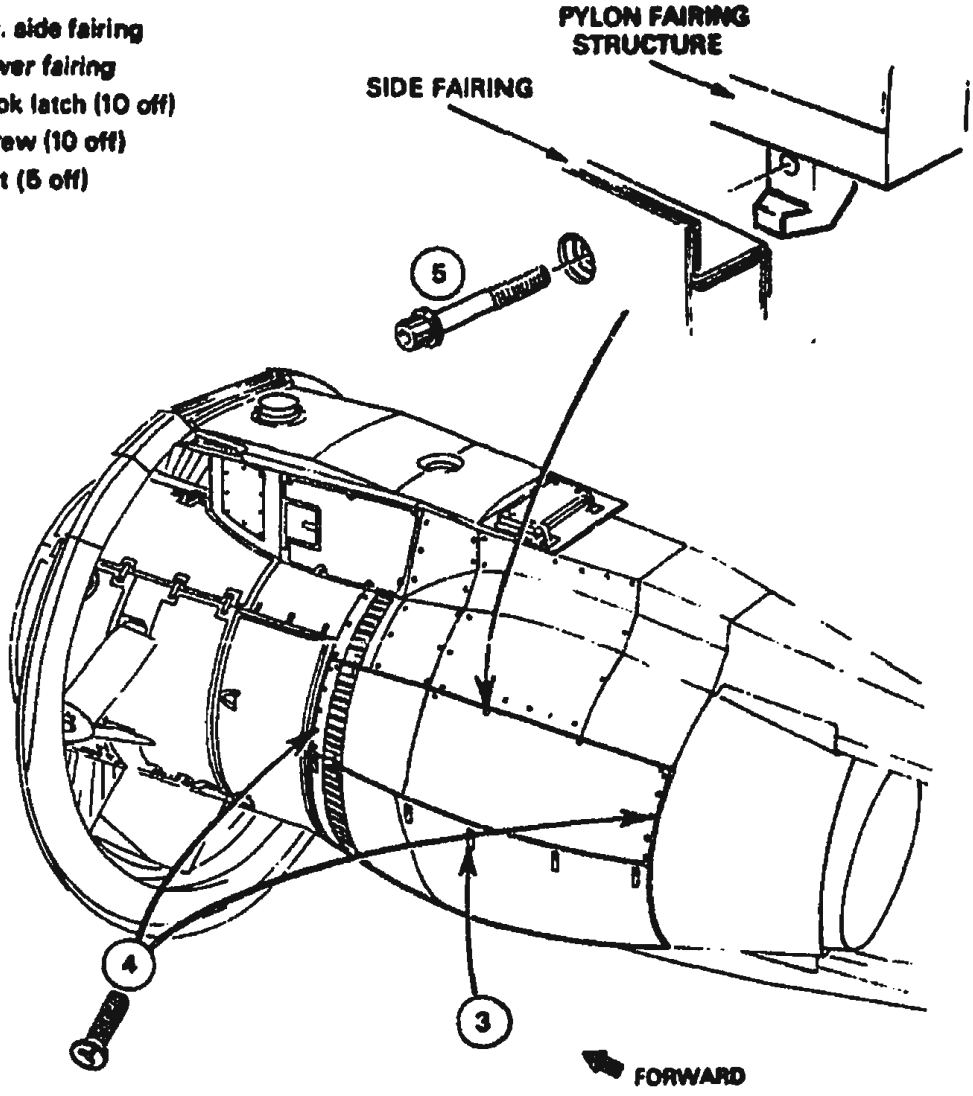
C. Install Turbine Section Fairings - Engines without S.B.78-3551

CAUTION: THE WEIGHT OF THE TURBINE SECTION LOWER FAIRING IS APPROXIMATELY 76 LB (34,5 KG) AND THAT OF THE L.H. AND R.H. FAIRINGS IS APPROXIMATELY 26 LB (11,3 KG)

(1) Equipment required:

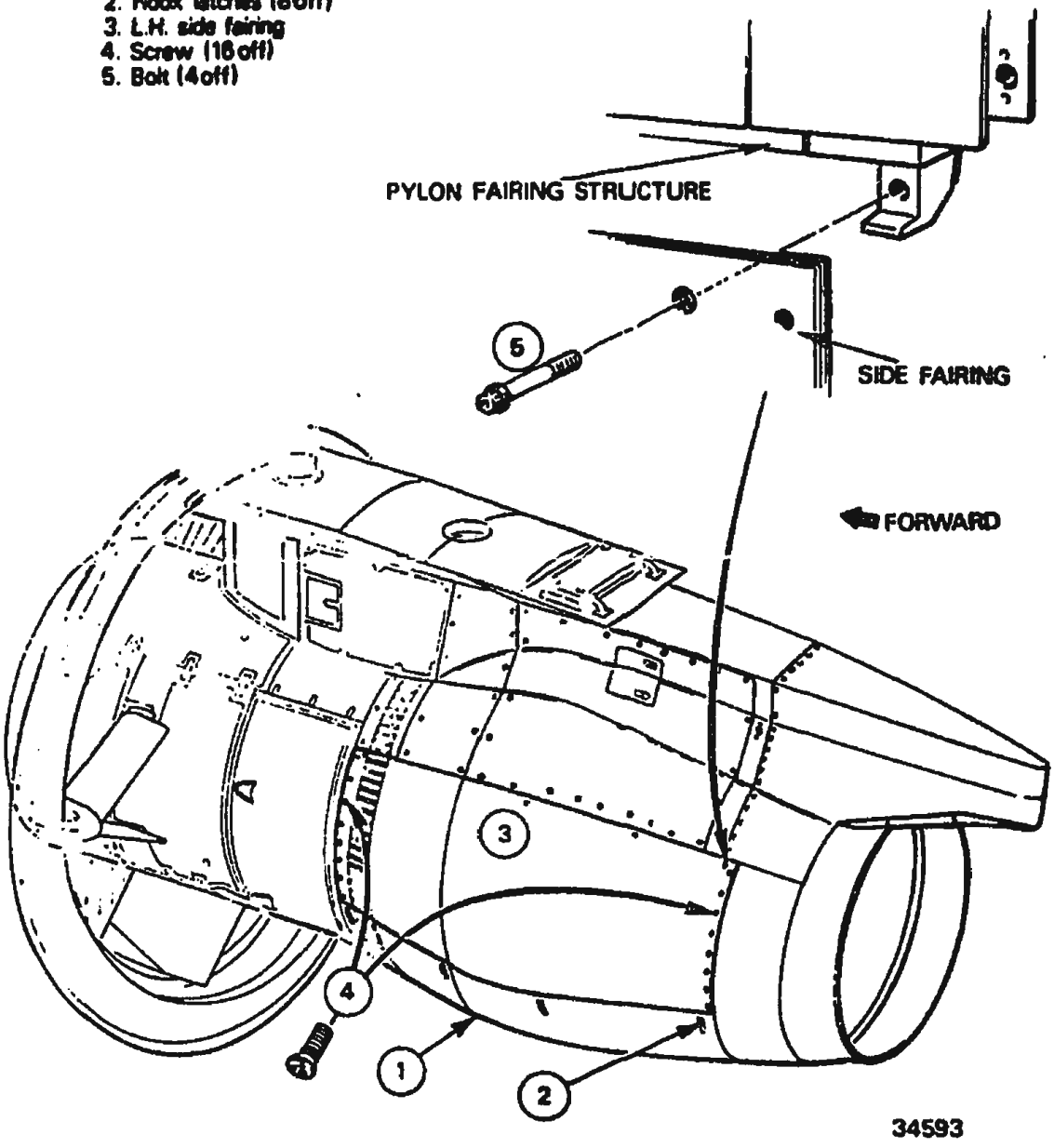
289200 or C 4G 4342 Protective work mats
HU21580 Load gauge

1. L.H. side fairing
2. Lower fairing
3. Hook latch (10 off)
4. Screw (10 off)
5. Bolt (5 off)




Turbine section fairings - Removal/Installation
(Engines without S.B.78-3551)
Fig.401 (Sheet 1)

1. Lower fairing
2. Hook latches (8off)
3. L.H. side fairing
4. Screw (16off)
5. Bolt (4off)




Turbine section fairings - Removal/Installation
(Engines with S.B.78-3551)
Fig.401 (Sheet 2)

(2) Ensure thrust reverser is locked and systems deactivated and tagged as detailed in operation 1.A. (2).

(3) Position protective work mats in cold stream duct.

(4) Refer to fig.401 (Sheet 1), position side fairing (1) at pylon fairing interface and secure with bolts (5). Secure along leading and trailing edges with screws (4).

(5) Repeat operation (4) for R.H. side fairing.

(6) CAUTION: ENSURE TURBINE DRAIN TUBE IS CORRECTLY ALIGNED IN TURBINE LOWER FAIRING. FAILURE TO DO SO CAN RESULT IN DRAIN TUBE OUTLET BEING RESTRICTED.
Position lower fairing (2), engage hook latches (3) with side fairings and fully close.

(7) In the event that turbine section lower fairing is replaced by a new fairing, carry out following latch load check:
Position a load gauge HU21580 smaller diameter end 0.5in. (12,70 mm.) from both centre latches (3) free end and simultaneously check that load required to fully close each hook latch is within the limits 20-28 lbf. (89-124.6 N.).

(8) Remove protective work mats.

(9) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

D. Install Turbine Section Fairings - Engines with S.B.78-3551

CAUTION: THE WEIGHT OF THE TURBINE SECTION LOWER FAIRING IS APPROXIMATELY 44.5 LB. (20,02 KG.) AND THAT OF THE L.H. AND R.H. SIDE FAIRINGS IS APPROXIMATELY 32.5 LB. (14,62 KG.).

(1) Equipment required:

| | |
|---|---|
| 289200 or C 4G 4342 | Protective work mats |
| HU21580 | Load gauge |

(2) Ensure thrust reverser is locked and systems deactivated and tagged as detailed in operation 1.B.(2).

(3) Position protective work mats in cold stream duct.

(4) Refer to fig.401 (Sheet 2), position side fairing (3) at pylon fairing interface and secure with bolts (5). Secure along leading and trailing edges with screws (4).

(5) Repeat operation (4) for R.H. side fairing.

(6) CAUTION: ENSURE TURBINE DRAIN TUBE IS CORRECTLY ALIGNED IN TURBINE LOWER FAIRING. FAILURE TO DO SO CAN RESULT IN DRAIN TUBE OUTLET BEING RESTRICTED.
Position lower fairing (1) ensuring correct alignment between turbine overboard drain housing assembly and lower fairing drain tube adapter seal and engage hook latches (2) with side fairings and fully close.

(7) In the event that turbine section lower fairing is replaced by a new fairing, carry out following latch load check:
Position load gauge HU21580 smaller diameter end 0.5in. (12,70 mm.) from both centre latches (2) free end and simultaneously check that load required to fully close each latch is within the limits 20-28 lbf. (89-124.6.N.).

(8) Remove protective work mats.

(9) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

## 2. Removal/Installation Combustion Section Fairings

| | | |
|---|---|---|
| | Combustion Section L.H. Fairing | 412JL, 422JL and 432JL |
| | Combustion Section R.H. Fairing | 412JR, 422JR and 432JR |
| R | Combustion Section Upper Fairing | 412N5, 422N5 and 432N5 |

Service Bulletins referred to:

74-4647 Combustion Section Fairings with Increased Hook Engagement and Lock

Illustrated Parts Catalogue References.

The I.P.C. sections where parts disturbed during the following operations can be located are as follows:

72-03-02 Combustion Section Gas Generator Fairings

A. Remove Combustion Section Fairings

CAUTION: THE WEIGHT OF THE COMBUSTION SECTION L.H. AND R.H. FAIRINGS IS APPROXIMATELY 20 LB (9,0 KG) AND THAT OF THE COMBUSTION SECTION UPPER FAIRING IS APPROXIMATELY 19 LB (8,6 KG).

(1) Equipment required:

| | |
|---|---|
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |

(2) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems and fit thrust reverser locks (Ref. 78-30-00, Servicing).

(3) Position working platform in cold stream duct.

(4) Refer to fig.402 (Sheet 1), release and disengage hook latches (3), taking care side fairings (2) and (4) do not swing out.

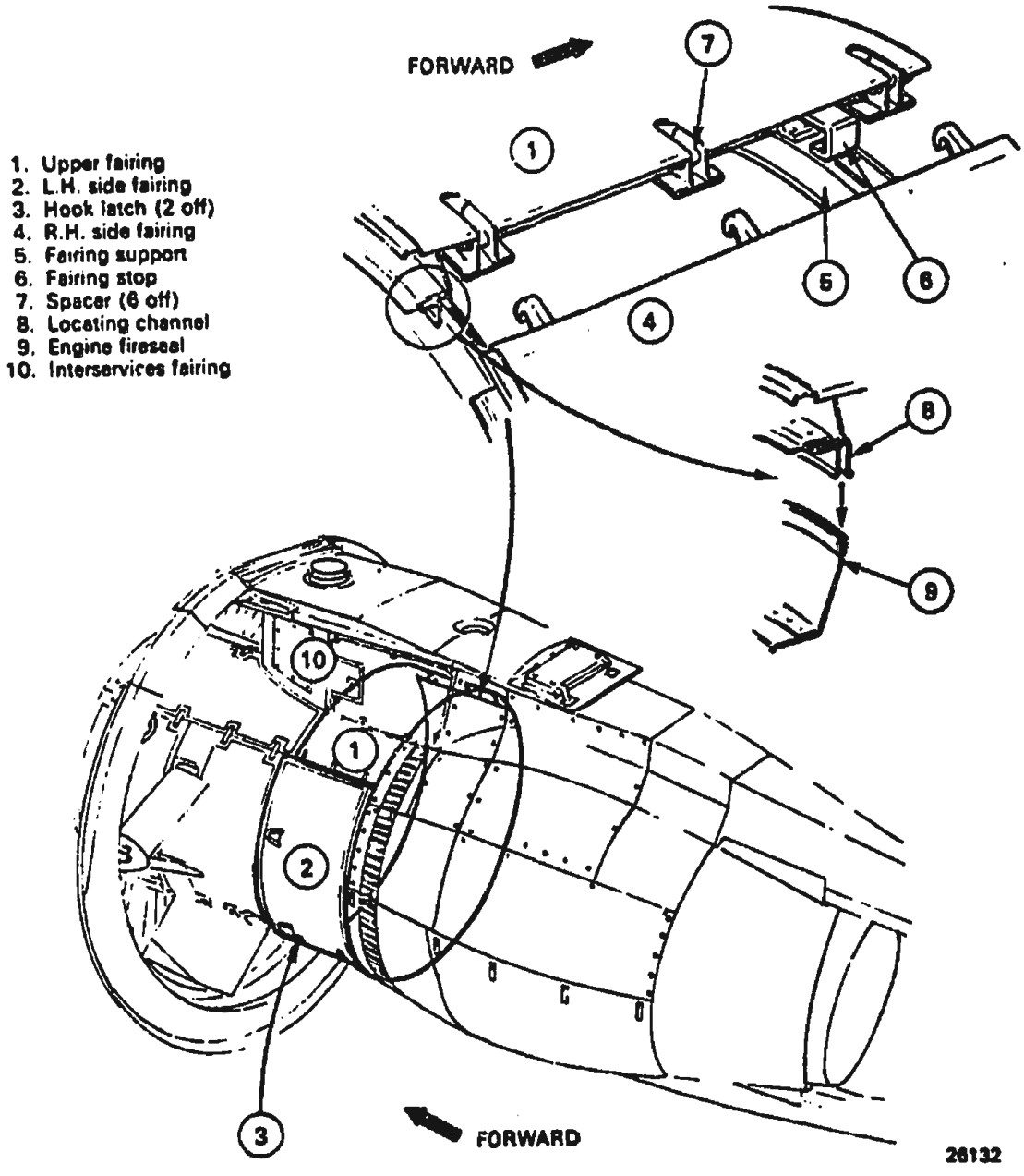
(5) Lift side fairing (2) to disengage hooks from spacers (7) on upper fairing (1) and remove.

(6) Repeat operation (5) for side fairing (4).

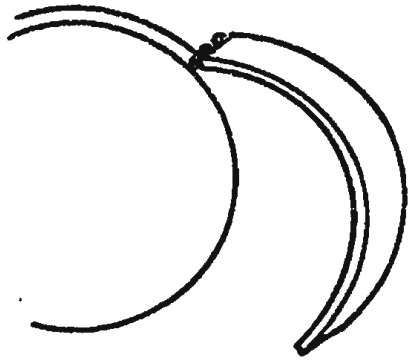
NOTE: Turbine section lower fairing must be removed before removing combustion section R.H. fairing.

(7) Remove upper fairing (1) by sliding to the left to clear interservices fairing (10).

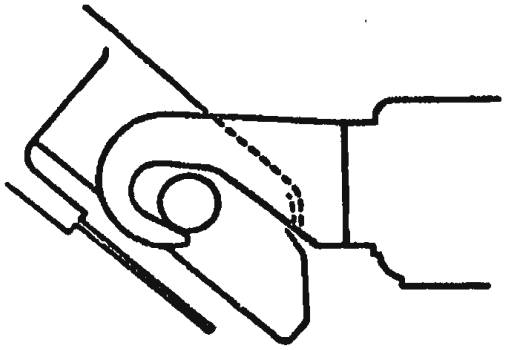
(8) Remove working platform.



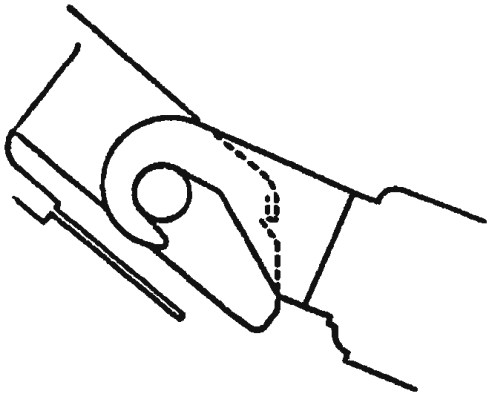

Combustion section fairings - Removal/Installation
Fig.402 (Sheet 1)



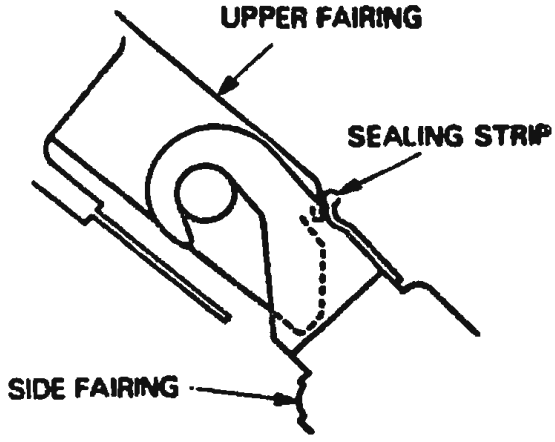
ENGAGE FRONT HOOK WITH FAIRING TILTED



STRAIGHTEN UP FAIRING AND ENGAGE CENTRE AND REAR HOOKS



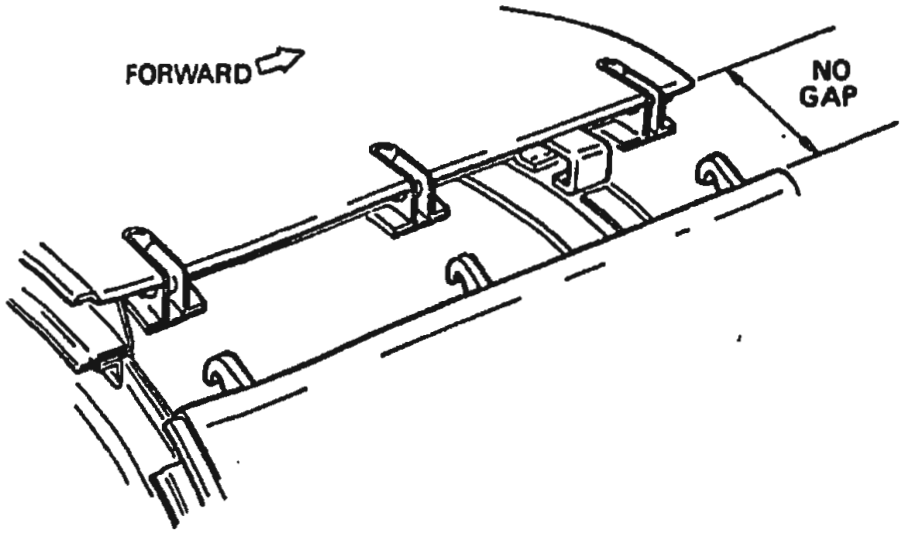
PULL HOOKS INTO FULL ENGAGEMENT AND LOWER FAIRING

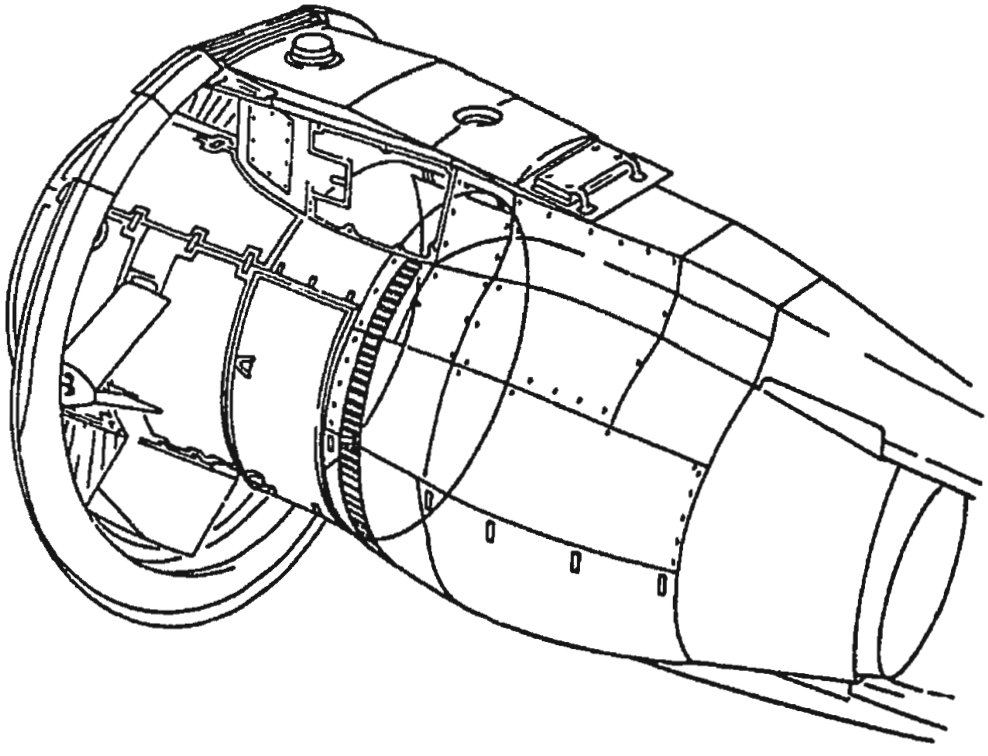



FAIRING IN POSITION

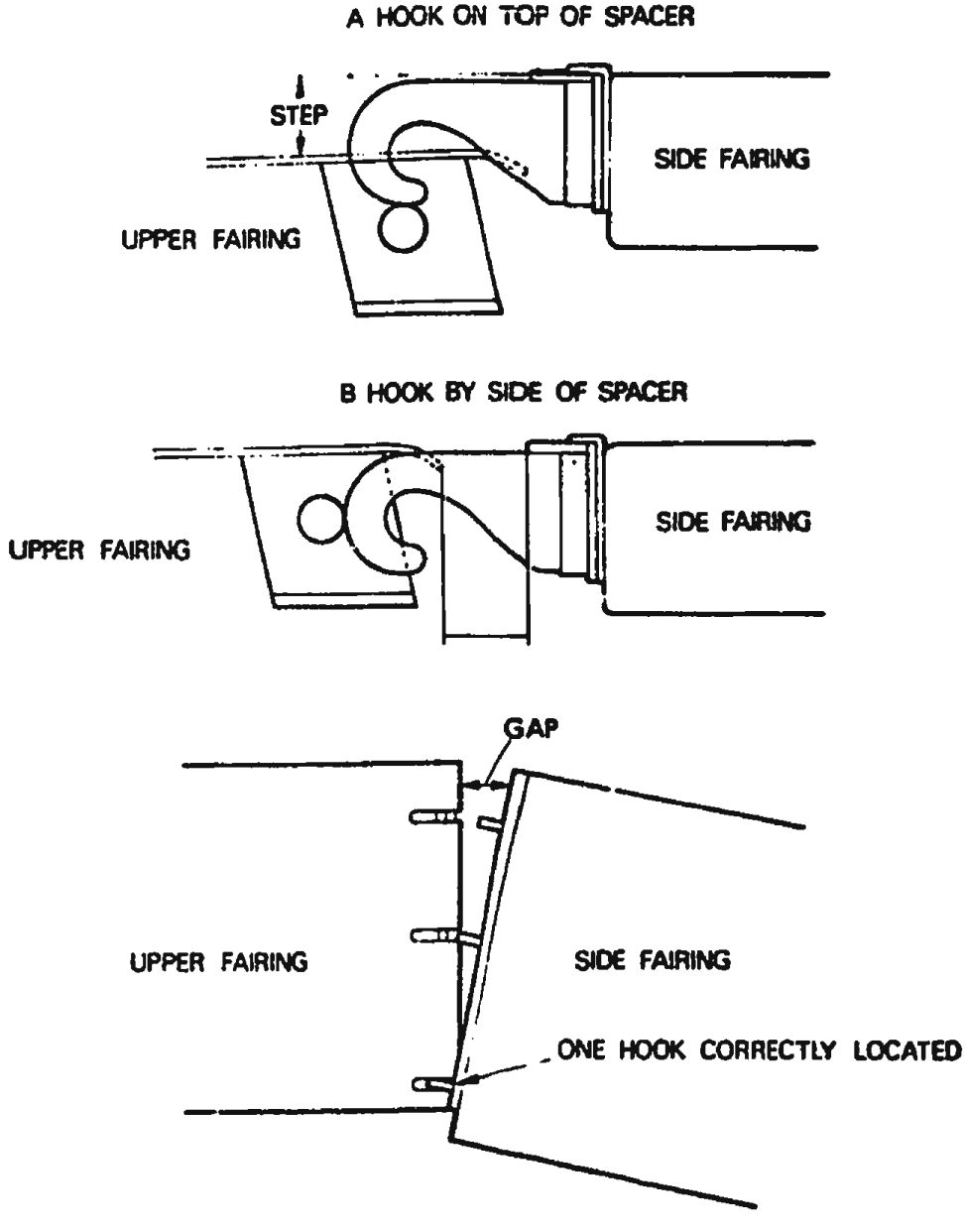
41254

R R Combustion section fairings - Removal/Installation
Fig.402 (Sheet 2)




CR Combustion section fairings - Removal/Installation
CR Fig.402 (Sheet 3)




R Combustion Chamber Fairing Installation
R Fig.402 (Sheet 4)

B. Install Combustion Section Fairings

CAUTION: THE WEIGHT OF THE COMBUSTION SECTION L.H. AND R.H. FAIRINGS IS APPROXIMATELY 20 LB (9,0 KG) AND THAT OF THE COMBUSTION SECTION UPPER FAIRING IS APPROXIMATELY 19 LB (8,6 KG).

NOTE: Compressor section rear fairings must be fitted before fitting combustion section fairings.

(1) Equipment required:

| | |
|---|---|
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |

(2) Ensure thrust reverser is locked and systems deactivated and tagged as detailed in operation 2.A. (2).

(3) Position working platform in cold stream duct.

(4) Refer to fig.402 (Sheet 1), position upper fairing (1) on L.H. side fairing support (5), with locating channel (8) located on fireseal (9). Slide fairing under interservices fairing (10) until it abuts fairing stop (6) on fairing support.

(5) Engines without S.B.72-4647 refer to fig.402 (Sheet 1) engage R.H. side fairing (4) hooks with upper fairing spacers (7). Support R.H. side fairing and fit L.H. side fairing in a similar manner.

Engines with S.B.72-4647 refer to fig.402 (Sheet 1 and 2), angle R.H. side fairing (4) forward and engage forward hook with its respective upper fairing spacer (7) then engage side fairing centre and rear hooks with remaining upper fairing spacers. Support R.H. side fairing and fit L.H. side fairing (2) in a similar manner.

NOTE: R.H. side fairing (4) must be fitted before L.H. side fairing (2).

(6) CAUTION : VISUALLY EXAMINE THE JOINT BETWEEN THE SIDE FAIRING SEALING STRIPS AND THE UPPER FAIRING TO ENSURE CORRECT HOOK ENGAGEMENT. INCORRECT ENGAGEMENT WILL BE INDICATED BY A STEP BETWEEN THE FAIRING EDGES IF THE HOOK IS SITTING ON TOP OF THE SPACER FIG.402 SHEET 3(A) OR A GAP BETWEEN THE EDGES IF THE HOOK IS JAMMED BY THE SIDE OF THE SPACER FIG.402 SHEET 3(B). IT IS NOT ADEQUATE TO ASSUME THAT HOOK ENGAGEMENT IS SATISFACTORY JUST BECAUSE IT WILL SUPPORT THE FAIRING BEFORE THE LATCHES ARE FASTENED. IT IS POSSIBLE FOR ONE OF THE THREE HOOKS TO ENGAGE PROPERLY AND FOR THE OTHERS TO MISS THEIR PINS. IN THIS CONDITION THE FAIRING MAY FEEL SECURE BUT CAN STILL BE RELEASED DURING ENGINE RUNNING.

WHERE ANY ONE OF THE COMBUSTION SIDE FAIRINGS HAS BEEN DISTURBED, NOT NECESSARILY REMOVED, IT IS ESSENTIAL THAT ALL COMBUSTION FAIRINGS ON BOTH SIDES OF THE CORE ENGINE ARE CHECKED FOR CORRECT ENGAGEMENT.

THIS MUST BE ACHIEVED BY CARRYING OUT A CLOSE INSPECTION OF THE FAIRINGS FOR STEPS AND GAPS AS DESCRIBED IN 'CAUTION' ABOVE.

Lower L.H. and R.H. side fairings (2) and (4) and check that side fairing sealing strip overlaps upper fairing.

(7) Refer to fig.402 (Sheet 1), close L.H. and R.H. side fairings (2) and (4) and engage hook latches (3). Position load gauge HU21580 smaller diameter end 0.5in. (12,70 mm.) from latch free end and check that load required to fully close each latch is within the limits 20-28 lbf. (89-124.6 N.).

(8) CAUTION: INCORRECT ASSEMBLY OF COMBUSTION SECTION FAIRINGS IS INDICATED BY A CIRCUMFERENTIAL STEP BETWEEN FAIRINGS.

Check combustion section fairings for correct assembly.

(9) Fit turbine section lower fairing (Ref. para.1).

(10) Remove working platform from cold stream duct.

(11) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

## 3. Removal/Installation Compressor Section Fairings

| | |
|---|---|
| Compressor Section Upper L.H. Fairing | 412AL, 422AL and 432AL |
| Compressor Section Upper R.H. Fairing | 412AR, 422AR and 432AR |
| Compressor Section Rear L.H. Fairing | 412FL, 422FL and 432FL |
| Compressor Section Rear R.H. Fairing | 412FR, 422FR and 432FR |
| Compressor Section Front L.H. Fairing | 412BL, 422BL and 432BL |
| Compressor Section Front R.H. Fairing | 412BR, 422BR and 432BR |

Service Bulletins referred to:

| | |
|---|---|
| S.B.72-2602 | Retained Support Bracket |
| S.B.72-3463 | Deletion of Enclosure Strap |
| S.B.72-5066 | Compressor R.H. lower fairing with additional mounting point |
| S.B.72-5814 | Radial Drive Fairing tie brackets with bolt isolation tubes. |

Illustrated Parts Catalogue References

The I.P.C. sections where parts disturbed during the following operations can be located are as follows:

72-03-01 Compressor Section Fairings

A. Remove Compressor Section Fairings

C RB211 Radial Drive Fairing Retaining Strap

C M.O. 94B96 adds a retaining strap that fits around the girth
C of the RB211 lower compressor fairings (Radial Drive
C Fairings). The strap prevents separation of the fairings
C with subsequent loss. The strap is fitted after installation
C of the fairings and is secured with two bolts and nuts at the
C trailing edge of the strap. (Figure 404).

CAUTION: THE WEIGHTS OF THE COMPRESSOR SECTION FAIRINGS ARE APPROXIMATELY AS FOLLOWS:

| | |
|---|---|
| L.H. AND R.H. UPPER FAIRINGS | 11 LB (5,0 KG) |
| L.H. FRONT FAIRING | 10 LB (4,5 KG) |
| R.H. FRONT FAIRING | 16 LB (7,3 KG) |
| L.H. LOWER FAIRING | 15 LB (6,8 KG) |
| R.H. LOWER FAIRING | 13 LB (5,9 KG) |

NOTE: Combustion section side fairings must be removed before removing compressor section rear fairings.

(1) Equipment required:

| | |
|---|---|
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |

(2) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems and fit thrust reverser locks (Ref. 78-30-00, Servicing).

(3) Position working platform in cold stream duct.

(4) Refer to fig.403, remove bolts (7) from closure plates (6) between front fairing (3) and lower fairing (5) and remove closure plates.

(5) Remove bolts (7) from closure plates (6) between front fairing (3) and upper fairing (2) and remove closure plates.

(6) CAUTION: DO NOT CONTINUE TURNING AFTER BOLT IS RELEASED BY SPRING LOAD.
Support front fairing (3) and slacken bolts (8) until bolt is released by spring load.

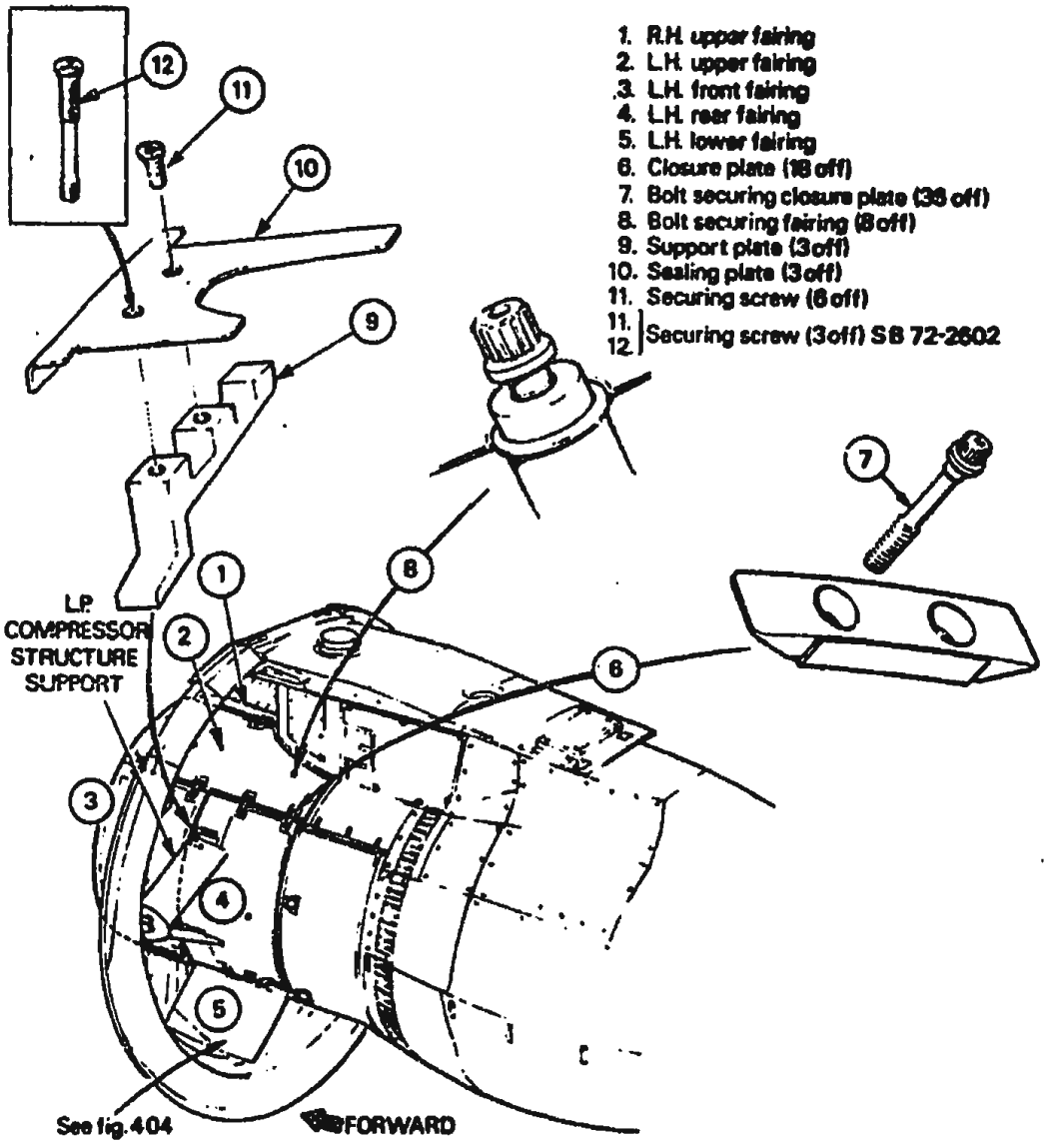
(7) Remove L.H. front fairing (3).

(8) Repeat operations (4) to (7) for R.H. front fairing.

(9) Remove screws (11) taking care that support block (9) does not fall between gas generator fairings and engine, then remove support block and sealing plate (10), noting position of sealing plates for reassembly.

On engines with S.B.72-2602, remove screw (11), release screw (12) until second thread is engaged in support block (9), then manoeuvre block and sealing plate (10) from around L.P. compressor case support structure, noting position of sealing plates for reassembly.

(10) Remove bolts (7) from closure plates (6) between rear fairing (4) and lower fairing (5) and remove closure plates.


1. R.H. upper fairing
2. L.H. upper fairing
3. L.H. front fairing
4. L.H. rear fairing
5. L.H. lower fairing
6. Closure plate (18 off)
7. Bolt securing closure plate (36 off)
8. Bolt securing fairing (8 off)
9. Support plate (3 off)
10. Sealing plate (3 off)
11. Securing screw (6 off)
11. 12. Securing screw (3 off) SB 72-2602
L.P. COMPRESSOR STRUCTURE SUPPORT
See fig.404
FORWARD
26133C

Compressor section fairing - Removal/Installation
Fig.403

(11) Remove bolts (7) from closure plates (6) between rear fairing (4) and upper fairing (2) and remove closure plates.

(12) CAUTION: DO NO CONTINUE TURNING AFTER BOLT IS RELEASED BY SPRING LOAD.
Support rear fairing (4) and slacken bolt (8) until bolt is released by spring load.

(13) Remove rear fairing (4).

(14) Repeat operations (9) to (13) for R.H. rear fairing.

(15) Remove bolts (7) from closure plates (6) between upper fairings (1) and (2); remove closure plates.

(16) CAUTION: DO NOT CONTINUE TURNING AFTER BOLTS ARE RELEASED BY SPRING LOAD.
Slacken bolts (8) on L.H. upper fairing (2) and R.H. upper fairing (1) until bolts are released by spring load.

(17) Remove upper fairings (1) and (2).

C (18) Refer to fig.404 (sheet 1), remove nuts and bolts (12) from retaining strap (11) and remove strap.

(19) Engines without S.B.72-5814 remove access panel (10) from R.H. lower fairing, and gaining access through panel aperture, release bolts (2) securing lower fairings (1) and (4).

(20) Remove bolts and washers (2) from fairing stiffeners (3).

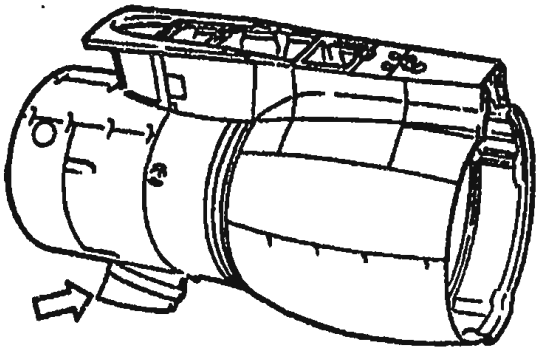
(21) Engines with S.B.72-5814 release and remove recessed bolts (2).

(22) Remove bolts and nuts (8).

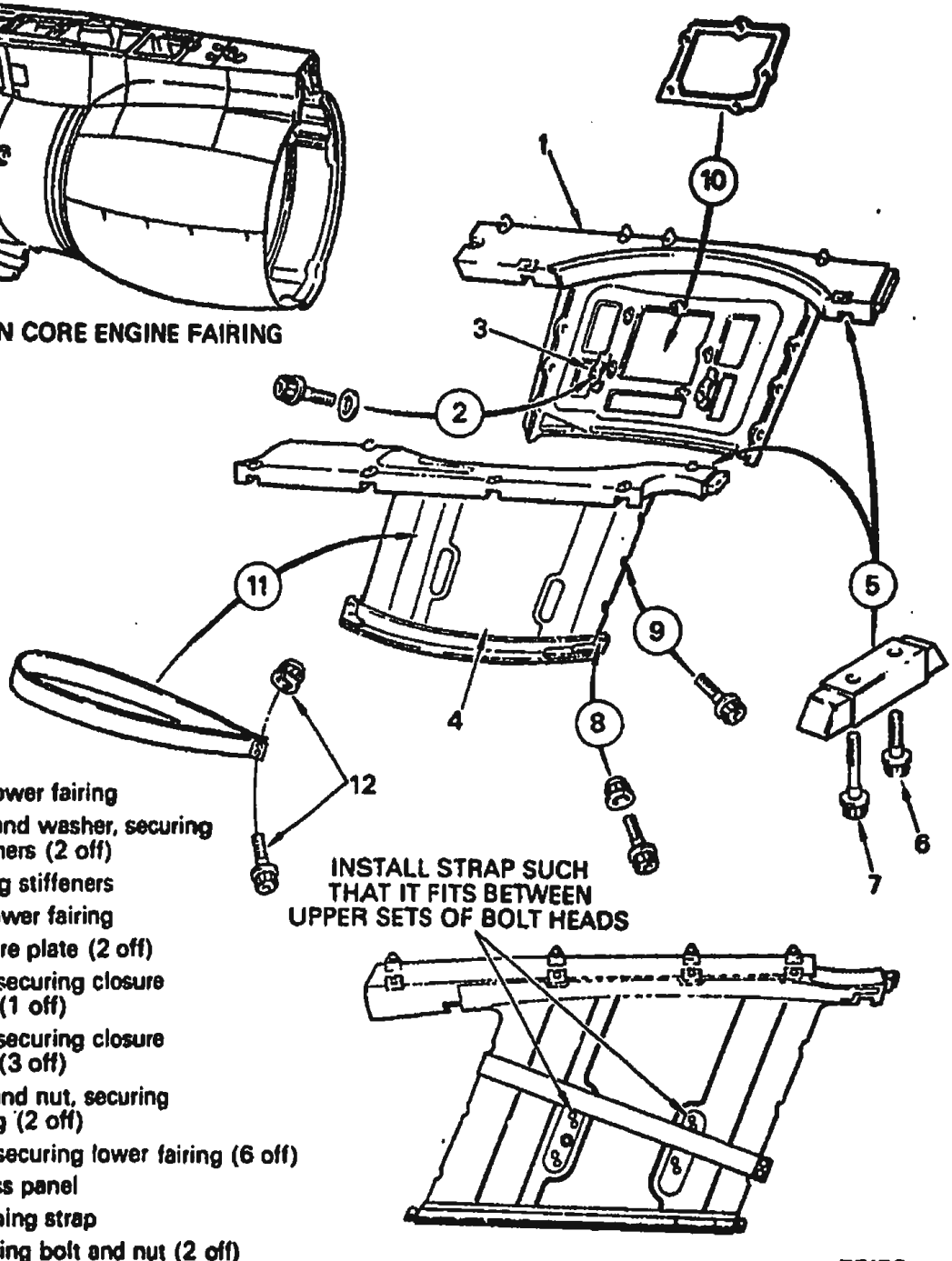
(23) Remove bolts (6) and (7) from rear closure plate (5) between lower fairings (1) and (4) and remove closure plate.

(24) Remove bolts (7) from front closure plate (5) and remove closure plate.

(25) Engines with S.B.72-5066 release bolt (10).



VIEW ON CORE ENGINE FAIRING

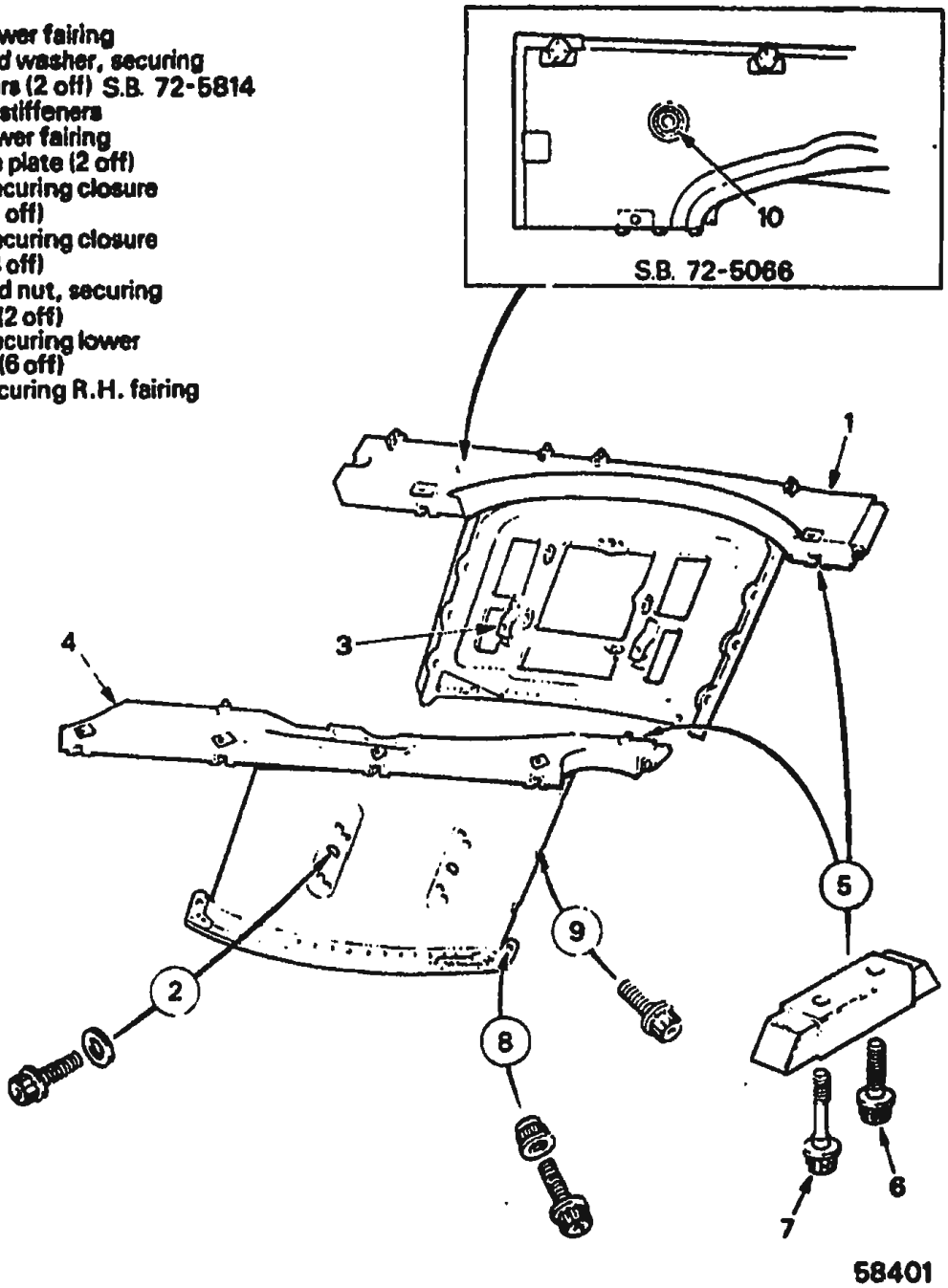



1 RH lower fairing
2 Bolt and washer, securing stiffeners (2 off)
3 Fairing stiffeners
4 LH lower fairing
5 Closure plate (2 off)
6 Bolt, securing closure plate (1 off)
7 Bolt, securing closure plate (3 off)
8 Bolt and nut, securing fairing (2 off)
9 Bolt, securing lower fairing (6 off)
10 Access panel
11 Retaining strap
12 Securing bolt and nut (2 off)

77158

CR CR Compressor section lower fairing - Removal/Installation Fig.404 (Sheet 1)

1. R.H. lower fairing
2. Bolt and washer, securing stiffeners (2 off) S.B. 72-5814
3. Fairing stiffeners
4. L.H. lower fairing
5. Closure plate (2 off)
6. Bolt, securing closure plate (1 off)
7. Bolt, securing closure plate (3 off)
8. Bolt and nut, securing fairing (2 off)
9. Bolt, securing lower fairing (6 off)
10. Bolt securing R.H. fairing




R Compressor section lower fairings - Removal/Installation
R Fig.404 (Sheet 2)

(26) Remove bolts (9) and remove lower fairings (1) and (4).

(27) Remove working platform.

B. Install Compressor Section Fairings

C RB211 Radial Drive Fairing Retaining Strap

C M.O. 94B96 adds a retaining strap that fits around the girth
C of the RB211 lower compressor fairings (Radial Drive
C Fairings). The strap prevents separation of the fairings
C with subsequent loss. The strap is fitted after
C installation of the fairings and is secured with two bolts
C and nuts at the trailing edge of the strap.

CAUTION: THE WEIGHTS OF THE COMPRESSOR SECTION FAIRINGS ARE APPROXIMATELY AS FOLLOWS:

| | |
|---|---|
| L.H. AND R.H. UPPER FAIRINGS | 11 LB (5,0 KG) |
| L.H. FRONT FAIRING | 10 LB (4,5 KG) |
| R.H. FRONT FAIRING | 16 LB (7,3 KG) |
| L.H. LOWER FAIRING | 15 LB (6,8 KG) |
| R.H. LOWER FAIRING | 13 LB (5,9 KG) |

R PRIOR TO INSTALLING COMPRESSOR SECTION FAIRINGS
R ENSURE THE COMPRESSOR FAIRING TO O.G.V. TORSION
R BOX SEAL IS SERVICEABLE 72-31-01 REFERS.

(1) Equipment required:

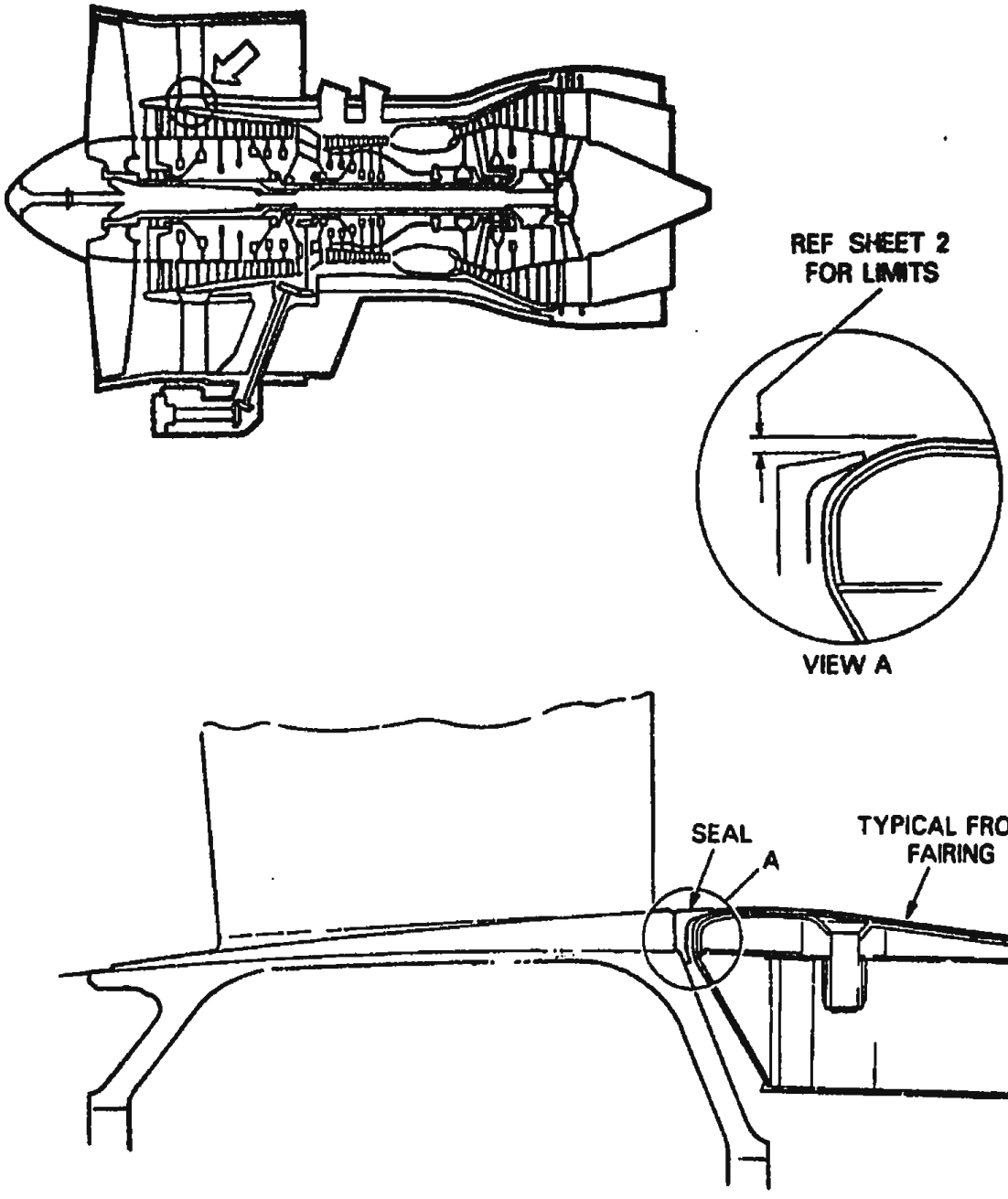
| | |
|---|---|
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |

(2) Ensure thrust reverser is locked and systems deactivated and tagged as detailed in operation 3.A. (2).

(3) Position working platform in cold stream duct.

(4) Refer to fig.404 (Sheet 1 or 2 as applicable), position lower fairings (1) and (4) around H.S. external gearbox drive and secure with bolts (9).

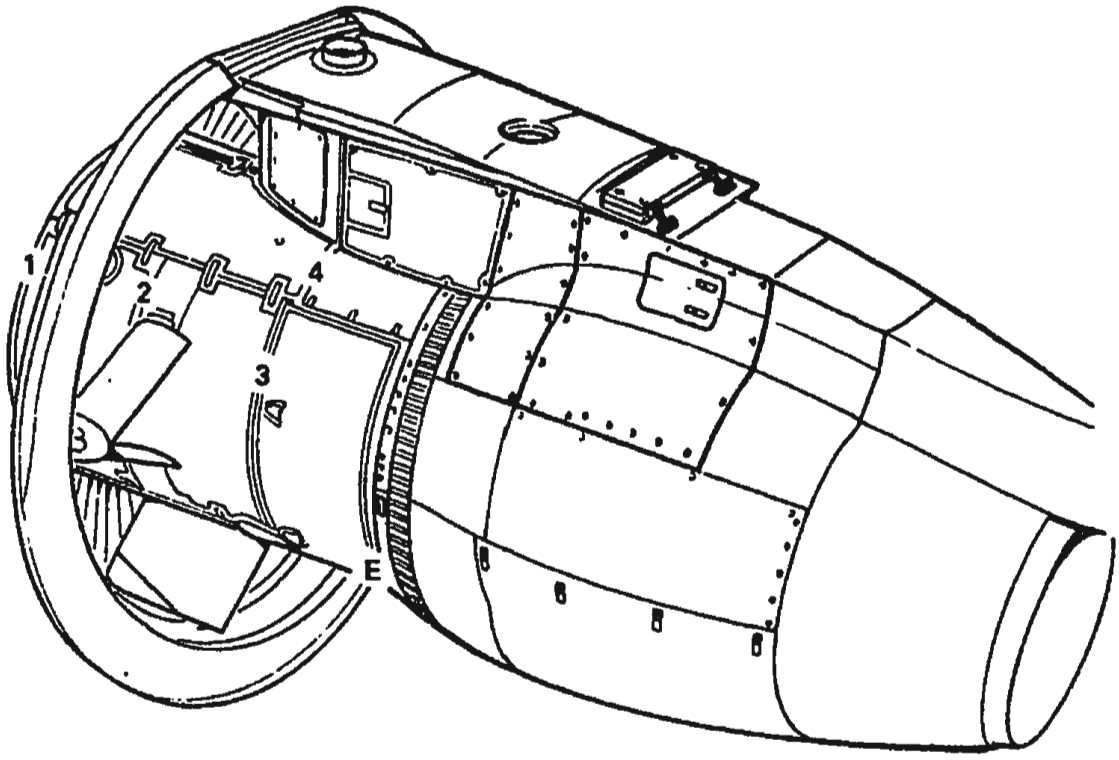
(5) Fit and secure bolts and nuts (8).




SECTION THROUGH L P COMPRESSOR, O G V ASSY SHOWING SEAL, O G V TORSION BOX TO COMP FAIRING

A9816

CR Compressor section fairings - Removal/Installation
CR Fig.404B (Sheet 1)




PERMISSIBLE MISMATCH OF COMPRESSOR SECTION FAIRINGS

| | LOCATION | PERMISSIBLE STEPS (Into/Out of wind) |
|---|---|---|
| 1 | UPPER FWD & LWR FAIRINGS | 0.250 in OVER 120° 0.063 in OVER BALANCE |
| 2 | REAR COMP FAIRINGS | 0.250 in OVER 120° 0.063 in OVER BALANCE |
| 3 | COMBUSTION FAIRINGS LWR | 0.250 in OVER 120° 0.063 in OVER BALANCE |
| 4 | COMBUSTION FAIRINGS UPR | 0.250 in OVER 120° 0.063 in OVER BALANCE |

A9817

CR Compressor section fairings - Removal/Installation
CR Fig.404B (Sheet 2)

(6) Fit front closure plate (5) and secure with bolts (7).

(7) Fit rear closure plate (5) and secure with bolt (7) in left-hand position and bolt (6) in right-hand position.

(8) Engine without S.B.72-5814 gain access through panel (10) aperture, fit washers and bolts (2) through R.H. fairing stiffeners (3).

(9) Locate bolts (2) in L.H. fairing stiffeners captive nuts and secure.

(10) Engines with S.B.72-5814 fit and secure recessed washers and bolts (2).

(11) Fit access panel (10).

C (12) Reinstall retaining strap (11), and secure with
C bolts (12).

(13) Engines with S.B.72-5066 secure bolt (10).

(14) Refer to fig.403, position upper fairing (1), locate bolts (8) and secure.

(15) Position upper fairing (2), locate bolts (8) and secure.

(16) Fit closure plates (6) between upper fairings and secure with bolts (7).

(17) Position rear fairing (4), locate bolt (8) and secure.

(18) Fit closure plates (6) between rear fairing (4) and upper fairing (2) and secure with bolts (7).

(19) Fit closure plates (6) between rear fairing (4) and lower fairings (5) and secure with bolts (7).

(20) Carefully position support block (9) and sealing plate (10) around L.P. compressor case support structure and secure with screws (11); before finally tightening screws, ensure sealing plate is pushed rearwards and centralized about pressure sensing (PF) rake and/or case support structure.

On engines with S.B.72-2602, pass screw (12) through hole in sealing plate (10), engage short threaded portion of screw in support block (9) and manoeuvre block and sealing plate into position around L.P. compressor case support structure and secure with screws (12) and (11). Before finally tightening screws, ensure sealing plate is pushed rearwards and centralized about pressure sensing (PF) rake and/or case support structure.

(21) Repeat operations (15) to (18) for R.H. rear fairing.

(22) Position front fairing (3), locate bolt (8) and secure.

(23) Fit closure plates (6) between front fairing (3) and upper fairing (2) and secure with bolts (7).

(24) Fit closure plates (6) between front fairing (3) and lower fairing (5) and secure with bolts (7).

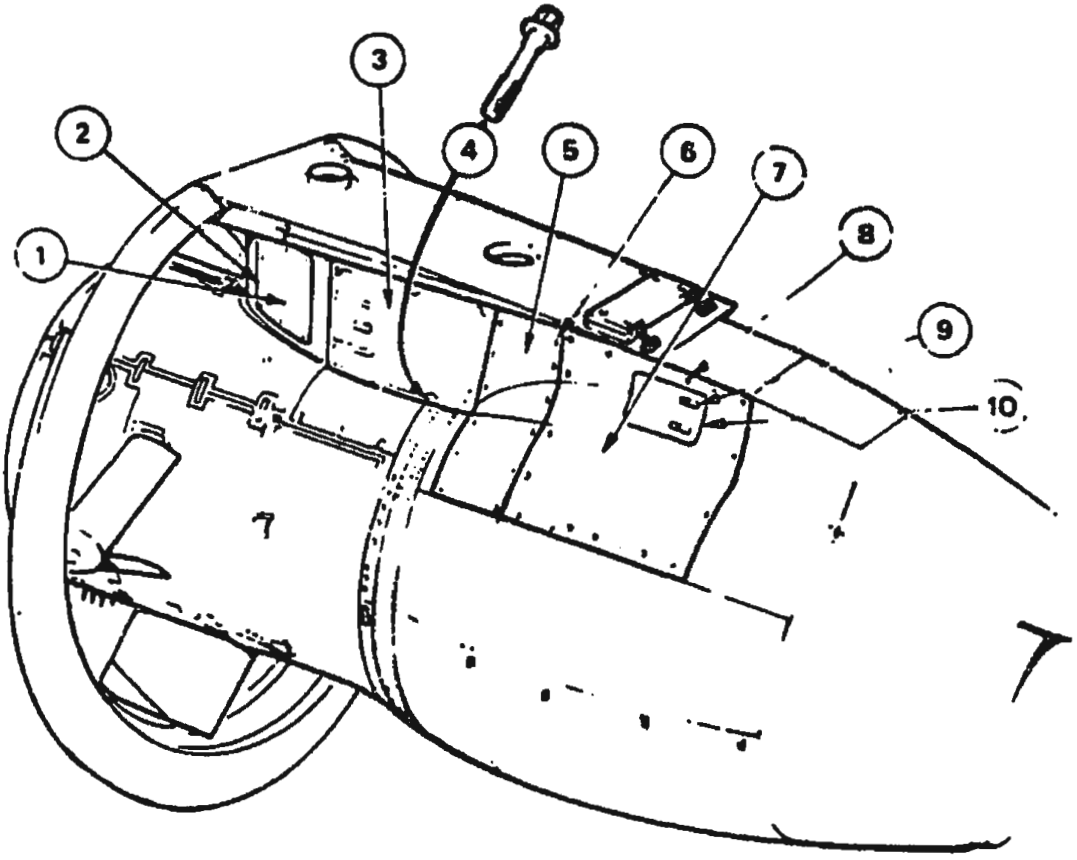
(25) Repeat operations (20) to (22) for R.H. front fairing.

(26) Inspect around the full circumference the step between the O.G.V. torsion box seal and the leading edge of the compressor fairings. Fig.404B, Sheet 1 refers to location; Fig.404B Sheet 2 gives permissible steps at this location and other locations in the compressor fairing build up.

CR
CR
CR
CR

(27) Remove working platform.

(28) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).




1. Nose section access panel
2. Panel fastener (10off)
3. Fairing access panel
4. Panel retainar bolt (7off)
5. Rear access panel
6. Panel fastener (12off)
7. Pylon fairing access panel
8. Panel fastener (17off)
9. Fastener (2off) (SB 72-3609)
10. Air motor brake release access panel (SB 72-3609)

FORWARD

26919A

Interservices fairing access panels disconnect points
Fig.405

## 4. Removal/Installation Interservices Access Panels

| | |
|---|---|
| IP HP Duct Access Panel | 418AL, 428AL and 438AL |
| L.H. Interservices Access Panel | 418BL, 428BL and 438BL |
| R.H. Interservices Access Panel | 418BR, 428BR and 438BR |
| Pylon Fairing Upper L.H. Access Panel | 418CL, 428CL and 438CL |
| Pylon Fairing Upper R.H. Access Panel | 418CR, 428CR and 438CR |
| Air Motor L.H. Access Panel | 418DL, 428DL and 438DL |
| Air Motor R.H. Access Panel | 418DR, 428DR and 438DR |

Service Bulletin referred to:

S.B.72-3609 Interservices Fairing - Quick Release Panel - Air Motor Brake Release

Referenced Procedures:

78-30-01 Thrust Reverser System In-flight Locking - Maintenance Practices

Illustrated Parts Catalogue References:

The I.P.C. sections where parts disturbed during the following operations can be located are as follows:

72-03-04 Engine/Power Plant Interservices Section

A. Remove Interservices Access Panels

(1) Equipment required:

| | |
|---|---|
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |
| UT.951/1 | Screwdriver |

(2) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated system and fit thrust reverser locks (Ref. 78-30-00, Servicing).

(3) Position working platform in cold stream duct.

(4) Refer to fig.405, using screwdriver UT.951/1 release fasteners (2) and remove nose section L.H. access panel (1).

(5) Remove bolts (4) and remove fairing L.H. access panel (3).

(6) Using screwdriver UT.951/1, release fasteners (6) and remove L.H. rear access panel (5).

(7) Using screwdriver UT.951/1, release fasteners (8) and remove pylon fairing L.H. access panel (7).

(8) Repeat operations (4) to (7) for R.H. access panels.

(9) On engines with S.B.72-3609, in order to gain access for releasing air motor brake release (Ref. 78-30-01) only. Release fasteners (9) and remove air motor brake release access panel (10).

(10) Remove working platform.

B. Install Interservices Access Panels

(1) Equipment required:

| | |
|---|---|
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |
| UT.951/1 | Screwdriver |

(2) Ensure thrust reverser is locked and systems deactivated and tagged as detailed in operation 4.A.(2).

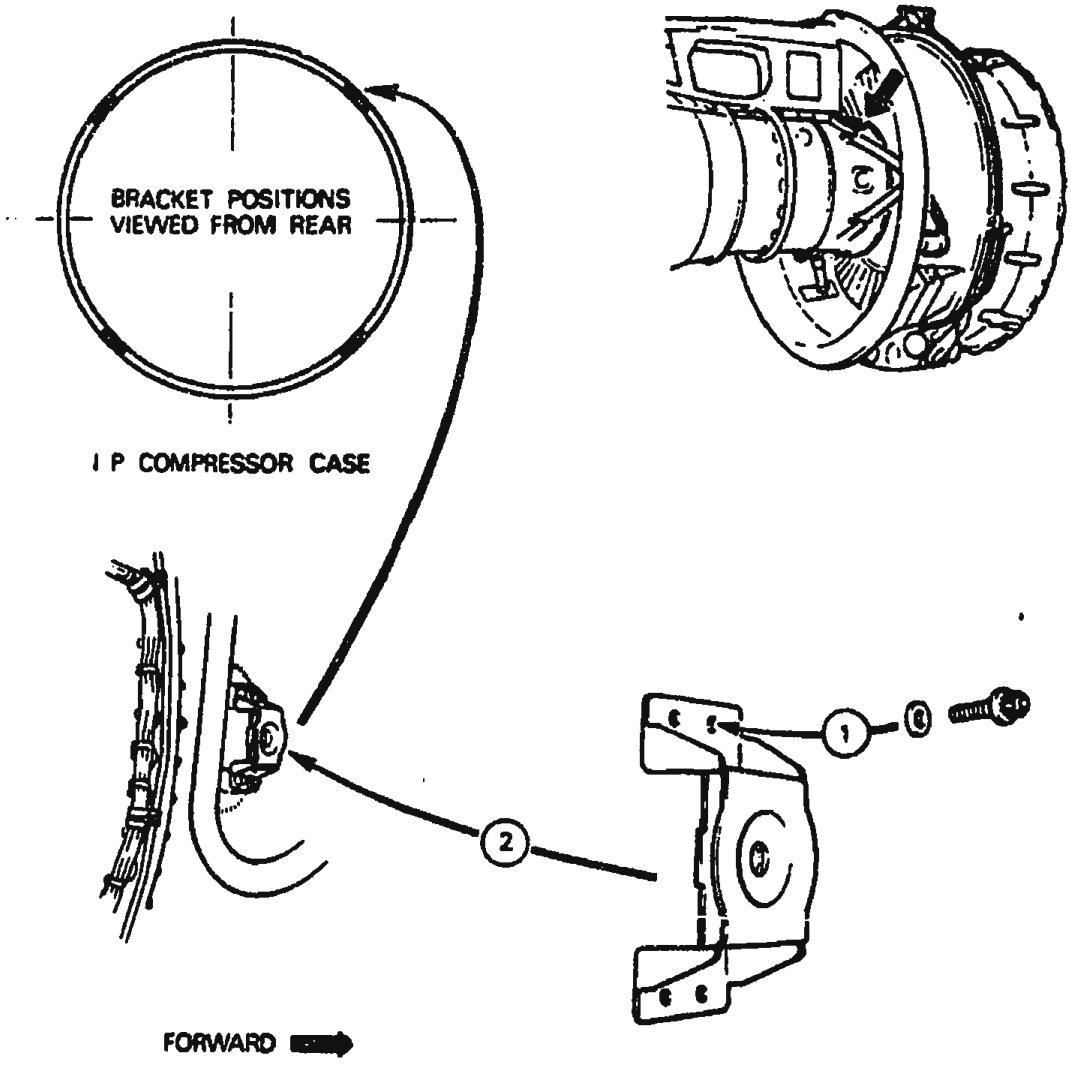
(3) Position working platform in cold stream duct.

(4) Refer to fig.405, position pylon fairing L.H. access panel (7) to fairing; using screwdriver UT.951/1 secure fasteners (8).

(5) Position L.H. rear access panel (5) to fairing; using screwdriver UT.951/1 secure fasteners (6).

(6) Position fairing L.H. access panel (3) to fairing; fit and secure bolts (4).

(7) Position nose section L.H. access panel (1) to fairing; using screwdriver UT.951/1 secure fasteners (2).




1. Securing bolt and washer (4 off)
2. Mounting bracket (1 off)

31324

Compressor section fairing forward mounting bracket - Removal/Installation
Fig.406

(8) Repeat operations (4) to (7) for R.H. access panels.

(9) On engines with S.B.72-3609, if access was required for releasing air motor brake release (Ref.78-30-01) only. Fit air motor brake release access panel to pylon fairing L.H. access panel (7) and secure fasteners (9).

(10) Remove working platform.

(11) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

5. Removal/Installation Compressor Fairings Forward Mounting Brackets

Illustrated Parts Catalogue References:

The I.P.C. sections where parts disturbed during the following operations can be located are as follows:

72-03-01 Compressor Section Fairings

A. Remove Fairing Mounting Brackets

(1) Equipment required:

| | |
|---|---|
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |

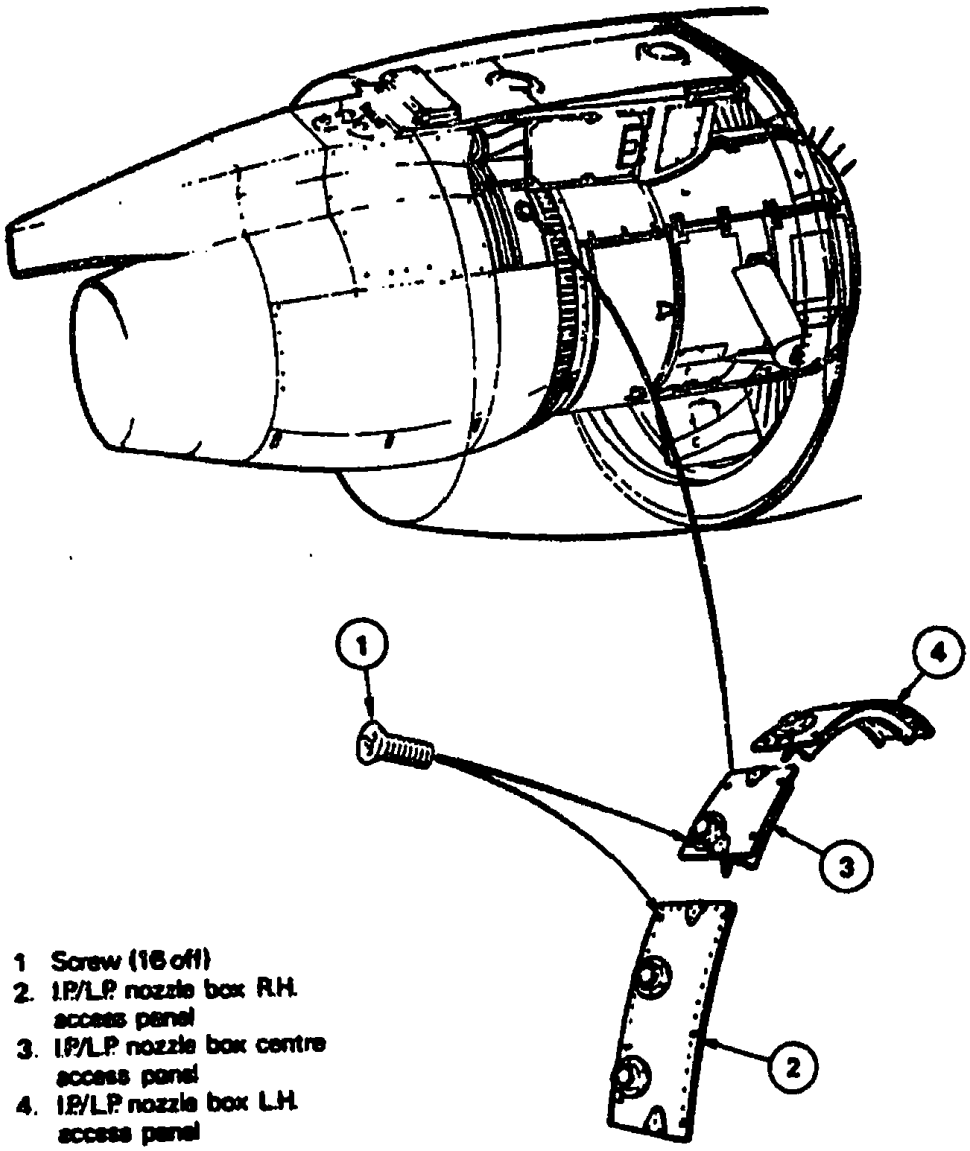
(2) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems and fit thrust reverser locks (Ref. 78-30-00, Servicing).

(3) Position working platform in cold stream duct.

(4) Remove compressor section fairings (Ref. para.3.A.).

(5) Refer to fig.406, remove bolts and washers (1) and remove bracket (2).

(6) Remove working platform.




1. Screw (16 off)
2. I.P/L.P. nozzle box R.H. access panel
3. I.P/L.P. nozzle box centre access panel
4. I.P/L.P. nozzle box L.H. access panel

36227

I.P./L.P. nozzle box access panels - Removal/Installation
Fig.407

B. Install Fairing Mounting Brackets

(1) Equipment required:

| | |
|---|---|
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |

(2) Ensure thrust reverser is locked and systems deactivated and tagged as detailed in operation 5.A.(2).

(3) Position working platform in cold stream duct.

(4) Refer to fig.406, position bracket (2) on I.P. compressor case and secure with bolts and washers (1).

(5) Fit compressor section fairings (Ref. para.3.B.).

(6) Remove working platform.

(7) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

6. Removal/Installation I.P./L.P. Nozzle Box Access Panels

Illustrated Parts Catalogue References:

The I.P.C. sections where parts disturbed during the following operations can be located are as follows:

72-03-04 Engine/Power Plant Interservices Section

A. Remove I.P./L.P. Nozzle Box Access Panels

(1) Remove interservices L.H. and R.H. rear access panel (Ref. para. 4.A.(1), (2), (3) and (5)).

(2) Refer to fig.407, remove screws (1), then remove panels (2), (3) and (4).

3. Install I.P./L.P. Nozzle Box Access Panels

(1) Refer to fig.407, fit panels (2), (3) and (4), and secure with screws (1).

(2) Fit interservices L.H. and R.H. rear access panel (Ref. para. 4.B.(1), (2), (3) and (6)).

7. Gas Generator Fairing Support Bracket Installation

CAUTION: IMPROPER INSTALLATION OF FAIRING SUPPORT BRACKET CAN CAUSE BRACKET TO BREAK AND ULTIMATELY LEAD TO FAILURE OF CORE COWLS.

A. Install bracket on engine in such a manner that vibro peened part number on bracket is facing forward on the engine.

NOTE: New brackets have a decal indicating correct installation of bracket, but decal soon fades or peels off bracket leaving the above method as best way to assure correct bracket installation.

# GAS GENERATOR FAIRINGS - INSPECTION/CHECK

R 1. General

R A. The Inspection/Acceptance procedures described in this section
R are as follows:

| R | Paragraph | Procedure |
|---|---|---|
| R | 1. | General |
| R | 2. | Inspect Gas Generator Fairings |
| R | 3. | Acceptance standards for Gas Generator Fairings |
| R | 4. | Inspect Pylon Fairings |
| R | 5. | Acceptance standards for Pylon Fairings |
| R | 6. | Thrust Reverser Finger Seals |

R B. Referenced Procedures

R 70-42-26 Stop Drilling

R 2. Inspect Gas Generator Fairings

A. Inspect gas generator fairings and interservices fairing and panels for cracks, dents and distortion, scores, scratches and abrasions.

B. Inspect glass reinforced composite (G.R.C.) for lifting of laminations, nicks, chafing and frettage.

C. Inspect rivets for looseness or pulling.

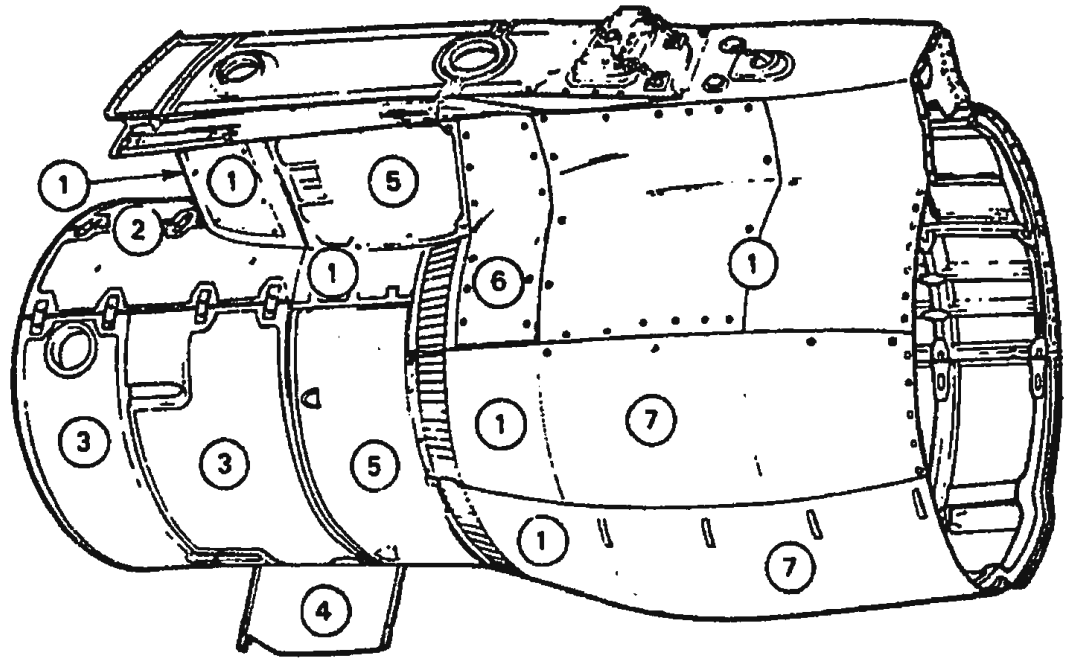
D. Inspect panel stiffeners for distortion and thinning.

E. Inspect perforate panels for cuts, holes, lifting or tearing.

F. Cracks which have been stop drilled, should be monitored to ensure further cracking does not occur.

C G. Inspect for damaged or missing finger seals.

R H. For acceptance standards see para.3.




FORWARD

1. Titanium
2. Alum. perf. outer skin – titanium inner skin
3. Alum perf. outer skin – G.R.C. inner skin
4. G.R.C.
5. Steel perf. outer skin – steel inner skin
6. Steel
7. Alum. alloy

26026

Gas generator fairings and panels material identification
Fig.601

R 3. Acceptance standards for Gas Generator Fairings

A. Cracks emanating from outer edge of any fairing are not acceptable.

B. Cracks in vicinity of any panel fastener are not acceptable.

R C. Compressor section fairings, refer Fig.603

(1) Aluminium perforates

(a) Cracks up to 0.50in. (12,70 mm.) in length provided they do not run out to panel edge.

(b) Score to a depth not exceeding one seventh of material thickness and 2.0in. (50,80 mm.) in length.

(c) Smooth dents to a depth not exceeding 0.150in. (3,810 mm.), provided area of damage is not more than 2.0in. (50,80 mm.) diameter.

CR CR (d) For cracks, scores, dents in excess of (a), (b), (c), correct within 25 flight hours.

(e) Damage to pressure relief door, or R.H. front fairing on either side of pressure relief door, is not acceptable.

(2) Titanium

(a) Cracks up to 0.50in. (12,70 mm.) in length provided they are stop drilled with 0.1875in. (4,7625 mm.) diameter hole at crack extremities.

(b) Scores to a depth not exceeding one twenty-fifth of material thickness and 2.0in. (50,80 mm.) in length.

(c) Smooth dents to a depth not exceeding 0.10in. (2,540 mm.), provided area of damage is not more than 2.0in. (50,80 mm.) in diameter.

C C (d) For cracks, scores, dents in excess of (a), (b), (c), correct within 25 flight hours.

R R R R (e) Surface deterioration/debond, providing the sum total area is less than 10 per cent of the fairings total area and no single area is greater than 30 sq.in. (193.55 sq.cm.).

(3) G.R.C.

(a) Chafing and fretting through two laminations, provided area is sealed with an air curing resin sealer.

(b) Nicks, provided any exposed glass is sealed through resin coat with an air curing resin sealer.

R R R R (c) Surface deterioration/debond, providing the sum total area is less than 10 per cent of the fairings total area and no single area is greater than 30 sq.in. (193.55 sq.cm.).

(d) Damage in vicinity of fairing stiffener attachment positions on lower fairings is not acceptable.

C C (e) For problems in excess of (i), (iii), (iv), correct within 25 flight hours.

D. Combustion section fairings, refer Fig.601.

(1) Titanium

(a) Cracks, scores and dents in the upper fairing inner skin are not acceptable.

NOTE: The inner skin is coated with a brittle oxide layer that forms the flame breakout shield and any damage to this coating reduces the flame containment properties.

(b) Acceptance standards for remainder as 3.C.(2).

(2) Steel perforate

(a) Acceptance standards as 3.C.(1).

(3) Steel

(a) Cracks up to 1.0in. (25,40 mm.) in length, provided they are stop drilled with 0.1875in. (4,7625 mm.) diameter hole at crack extremities.

R (b) Scores and dents as 3.C.(1).

CR (c) For cracks, scores, dents in excess of (a), (b),
CR correct within 25 flights.

R E. Turbine section fairings, refer Fig.601

(1) Aluminium

R (a) Cracks as 3.D.(3).

R (b) Scores as 3.C.(1).

(c) Smooth dents to a depth not exceeding 0.250in. (6,350 mm.), provided area of damage is not more than 2.0in. (50,80 mm.) diameter.

CR (d) For cracks, scores, dents in excess of (a), (b),
CR (c), correct within 25 flight hours.

(2) Titanium

(a) Axial cracks in rear pylon fairing up to 4.0in. (101,60 mm.) in length, provided they are stop drilled at crack extremities with a 0.1875in. (4,7625 mm.) diameter hole.

R (b) Scores as 3.C.(2).

R (c) Dents as 3.C.(1).

C (d) Axial cracks, other cracks, scores, dents in
CR excess of (a), (b), (c), correct within 25
C flight hours.

F. Interservices fairing

R (1) Nose section fairing as 3.C.(2).

R (2) Titanium access panels as 3.C.(2).

R (3) Steel access panels as 3.D.(3).

R (4) Steel perforate access panels as 3.C.(1).

C (5) Cracks in interservices fairing structural members, including rear diaphragm, are not acceptable and must be
C corrected within 25 flight hours

G. Panel stiffeners

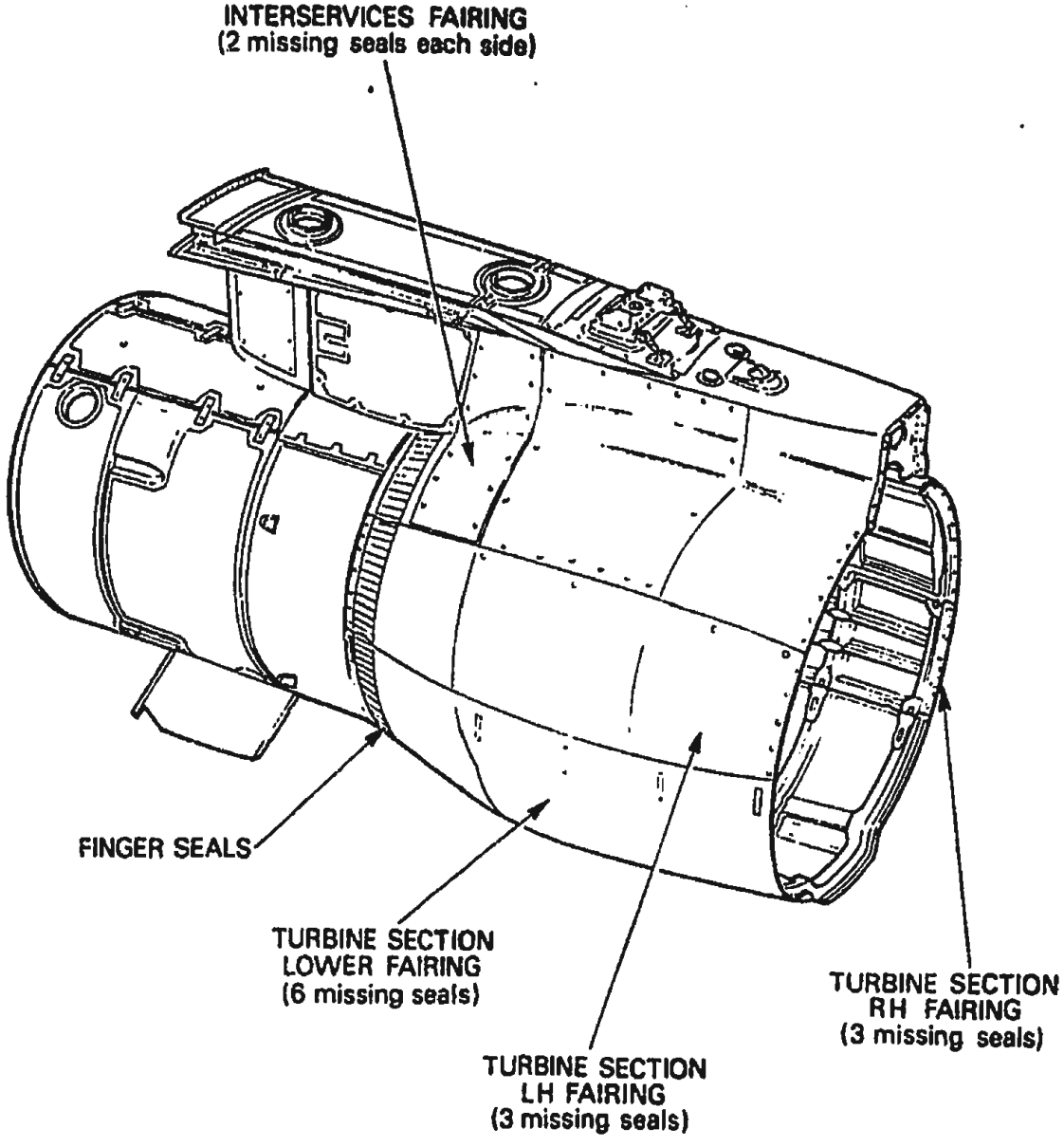
(1) Distortion of panel stiffeners is acceptable, provided the overall depth of damage does not exceed three times material thickness and area of damage
R does not exceed 1.50in. (38,10 mm.) in diameter.

CR (2) Distortion of panel stiffeners in excess of (1) are
C to be corrected within 25 flight hours.

(3) Thinning of panel stiffeners must not exceed half original thickness of material and area of damage must not exceed 1.500in. (38,100 mm.) in diameter.

R H. Rivets

(1) Loose rivets must be drilled out and next larger size fitted.




C Gas generator fairings and panels
C Fig.602

R 4. Inspect Pylon Fairing

R A. Inspect pylon fairing for cracks.

R B. Cracks which have been stop drilled should be monitored to
R ensure further cracking does not occur.

R C. For acceptance standards see para.5.

R 5. Acceptance Standards for Pylon Fairing

R A. Zone A, refer Fig.603.

R (1) Cracking in zone A not in excess of 0.50in. (12,70 mm.)
R is acceptable, provided cracks are stop drilled (Refer
R 70-42-26).

R (2) Cracking outside zone A is not acceptable.

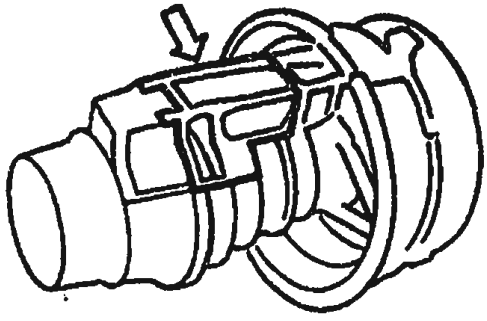
CR 6. Thrust Reverser Finger Seals, Ref. fig.602

C A. As many as six (6) individual finger seals may be
C broken or missing from the turbine section lower
C fairing, provided that there are not more than three
C (3) damaged seals in a row. Any loose or sharp
C metal should be removed.

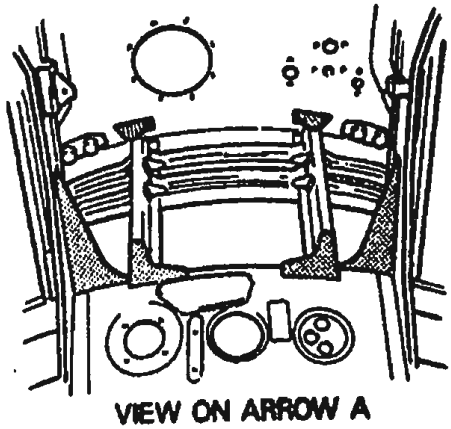
C B. As many as three (3) individual finger seals may
C be broken or missing from the L.H. and R.H. turbine
C section fairings. Any loose or sharp metal should
C be removed.

C C. As many as two (2) individual finger seals may be
C broken or missing from the L.H. and R.H. sides of
C the interservices fairing. Any loose or sharp
C metal should be removed.

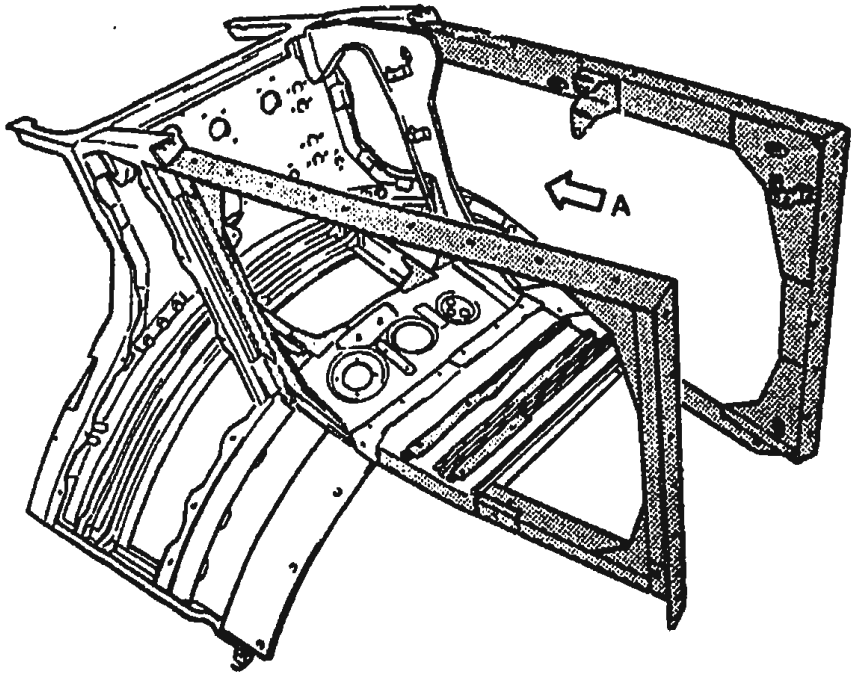
C D. Missing reverser finger seals in excess of (A), (B), (C),
C are to be corrected within 25 flight hours



NOTE: Shaded area is zone A



VIEW ON ARROW A




A6792

Pylon Fairing - Inspection/Check
Fig.603

## COMPRESSOR SECTION - CLEANING/PAINTING

Referenced Procedures:

| | |
|---|---|
| 71-12-01 | Hinged Cowls L.H. and R.H. Lower - Servicing |
| 71-00-00 | Power Plant - Maintenance Practices |
| 72-03-00 | Gas Generator Fairings - Removal/Installation |
| 72-31-05 | L.P. Compressor Disc and Blades - Cleaning/Painting |
| 78-30-00 | Thrust Reverser - Servicing |

CAUTION: 1. COMPRESSOR CLEANING MUST NOT BE ATTEMPTED AT AN AIR INLET TEMPERATURE BELOW 1 DEG.C (34 DEG.F.)

2. SALT BASED FLUIDS MAY CAUSE CORROSION OF THE METCO 601 I.P. COMPRESSOR ROTOR LINING, WHERE FITTED.

### 1. Compressor Cleaning

A. Clean L.P. H.P. and I.P. Compressors

(1) Equipment required:

| | |
|---|---|
| 289200 or C 4G 4342 | Protective work mats |
| or XUT.40959 | Work platform - nose cowl |
| CP20309 or XUT37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |

Light weight rope
Pressure washing rig (Local manufacture)

NOTE: The pressure washing rig must be fitted with a probe (nominal inside diameter 0.160in. (4,0 mm.)) capable of injecting fluid at pressures up to 100 p.s.i. and have a minimum capacity of:

20 Imperial gallons
24 U.S. gallons
90 Litres

(2) Material required:

R CAUTION: ENGINE WASHING MUST BE PERFORMED USING ONLY A WASHING FLUID LISTED BELOW AS THESE ARE NOT SALT BASED. SALT BASED CLEANING FLUIDS MAY CAUSE CORROSION OF I.P. COMPRESSOR ROTOR LINING (METCO 601) WHERE FITTED.

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| R Compressor Washing Fluid | Zok 27 | - | 1070 |
| R | Castrol ICD 177 | - | 1070A |
| R | Turbo Clean | - | 1070B |
| R | Ardrox 6345 | - | 1070D |
| R | Rivanaes RMC-G21 | - | 1070E |
| R Demineralised water | | | |

(3) WARNING: ENSURE THRUST REVERSER IS LOCKED IN FORWARD THRUST POSITION WHEN WORKING IN COLD STREAM DUCT.

Deactivate and tag thrust reverser and associated systems, and fit thrust reverser locks (Ref. 78-30-00).

(4) Engines No.1 or 3.

(a) Fit nose cowl work platform or protective work mats in air intake ensuring red warning pennants are clearly visible from aircraft exterior.

(5) Engine No.2

(a) Open access panels 433AL and 434AR (Ref. 71-12-01) and 431AZ.

(b) Position protective work mats in air intake ensuring that red pennants are clearly visible from the aircraft exterior.

(6) Fit working platform or spacer and side pieces in cold stream duct ensuring red warning pennants are clearly visible from aircraft exterior.

(7) Remove compressor section right hand (412FR or 422FR) front fairings (Ref. 72-03-00).

(8) On V.I.G.V. master ram, manually retract slave ram to open intake guide vanes by moving push rod toward slave ram.

(9) Remove work platform or spacer and side pieces from cold stream duct.

(10) Tie L.P. compressor blades to L.P. compressor outlet guide vanes tangentially at 3 positions using light weight rope.

R (11) WARNING: WHILST THE WASHING FLUIDS USED IN THE
R FOLLOWING PROCEDURES ARE NON-FLAMMABLE
R AND NON-TOXIC THEY ARE IRRITANTS.
R PRECAUTIONS SHOULD BE TAKEN IN ACCORDANCE
R WITH WASHING FLUID MANUFACTURERS
R INSTRUCTIONS.

Prepare approximately 20 gallons of washing fluid using a ratio by volume of 4 parts of demineralised water to 1 part of cleaning fluid.

R NOTE: Demineralised water may have a maximum
R conductance of 20 microsiemens.

(12) Dry motor engine (Ref. 71-00-00) for 2 minutes and during motoring cycle and subsequent rundown inject washing fluid at a pressure not exceeding 100 p.s.i. into the I.P. compressor, by steadily and continually orbiting the pressure washing rig probe around the L.P. compressor spinner whilst aiming the jet at the I.P. compressor stage 1 blade roots. Cease injection when N3 indication falls to 5%.

(13) Allow engine to soak for 10 minutes then repeat operation (12).

(14) Allow engine to soak for a further 10 minutes

(15) Dry motor engine for 2 minutes, and during motoring cycle and subsequent rundown, inject demineralised water at a pressure not exceeding 100 p.s.i. into the I.P. compressor by steadily and continually orbiting the pressure washing rig probe around the L.P. compressor spinner whilst aiming the jet at the I.P. compressor stage 1 blade roots. Cease injection when N3 indication falls to 5%.

(16) Allow 10 minutes for drainage then repeat operation (15).

(17) Dry motor engine for 2 minutes to assist drying.

(18) Fit work platform or spacer and side pieces in cold stream duct.

(19) On V.I.G.V. master ram, manually extend slave ram to close intake guide vanes by moving push rod away from slave ram.

(20) Refit compressor section right-hand front fairings (Ref. 72-03-00).

(21) Remove work platform or spacer and side piece from cold stream duct.

(22) Untie L.P. compressor blades.

(23) Clean L.P. compressor blades and roots (Ref. 72-31-02, Method 1).

(24) Remove work platform or protective work mats from air intakes.

(25) Engines No.2

(a) Close access panels 433AL and 434AR (Ref. 71-12-01) and 431AZ.

(26) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00).

(27) Perform engine drying procedure

NOTE: It is important that the drying out run is carried out immediately, to minimise the risk of carbon release from the 03 module.

(a) On engines without S.B.72-5528, remove the internal gearbox scavenge strainer element and refit MCD (or sealing plug) (Ref.72-01-00) prior to commencing procedure. Refit scavenge strainer element (Ref.72-01-00) on completion of procedure.

(b) Start engine and run at ground idle for 5 minutes (Ref.71-00-00). Engine condition:

No air offtake, I.D.G. disconnected or minimum load of 5 Kilowatts.

(c) Advance throttle lever slowly to acheive 1.20 E.P.R. and run at this power setting for 10 minutes.

NOTE: Monitor oil pressure, temperature and quantity. If OIL L.P. WARNING light illuminates or any parameter is likely to be exceeded, terminate procedure and repeat procedure with clean filters.

(d) Decelerate engine to ground idle and run at ground idle for 5 minutes.

(e) Stop engine (Ref.71-00-00).

(f) Remove fine scavenge and pressure filters (Ref.72-01-00) and visually inspect for carbon contamination. If no contamination visible, fit clean fine scavenge and pressure filters (Ref.72-01-00).

If fine scavenge and pressure filters contaminated, fit clean filters (Ref.72-01-00) then repeat operations (b) through (f).

## L.P. COMPRESSOR CASE AND VANES - ADJUSTMENT/TEST

Service Bulletins referred to:

Plessey S.B. I.G.V. 75-9 (Mod.2118) - Slave ram - Introduction - of strengthened front casing

Plessey S.B. I.G.V. 75-10 (Mod.2119) - Master ram - Introduction - of strengthened front casing

1. Set V.I.G.V. Operating Linkage

A. Equipment required:

| | |
|---|---|
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 - | Spacer |
| (XUT.42527 - | Side piece |

B. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Araldite filler | AV100 | AV100 | 812 |
| Araldite hardener | HV100 | HV100 | 813 |
| Degreasing fluid | BS.4487: 1969 | - | - |

WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS. Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref. 78-30-00, Servicing).

C. Position working platform in cold stream duct.

D. Enter cold stream duct and remove compressor section right-hand front gas generator fairing (Ref. 72-03-00, Removal/Installation).

E. Refer to fig.501, remove nuts and bolts (1) and (2).

F. Refer to fig.502, take up all movement in master ram, push rods and V.I.G.V. in direction of arrows.

G. Measure gap between master ram and push rod. This should be 0.008 to 0.016in. (0,20 to 0,40 mm.).

On master rams incorporating Plessey S.B. I.G.V. 75-10 (Mod.2119; MR.102.Mk2 - see Ram Data Plate) - the gap should be 0.031 to 0.039in. (0,79 to 0,99 mm.).

H. If within limits proceed to operation N. If outside of limits proceed with operation J.

J. Refer to fig.501, remove spacers (3) and (4) which are bonded to push rods then remove old bonding agent from push rod spigots.

K. Set slave ram linkage.

(1) Refer to fig.502, take up all movement in slave ram, push rods and V.I.G.V. in direction of arrows.

(2) Measure and record dimension AE.

(3) Add 0.008 to 0.016in. (0,20 to 0,40 mm.) to dimension AE and record as dimension AE1.

On slave rams incorporating Plessey S.B. I.G.V. 75-9 (Mod.2118; SR.102.Mk2 - see Ram Data Plate) - add 0.035 to 0.043in. (0,89 to 1,09) to dimension AE and record as dimension AE1.

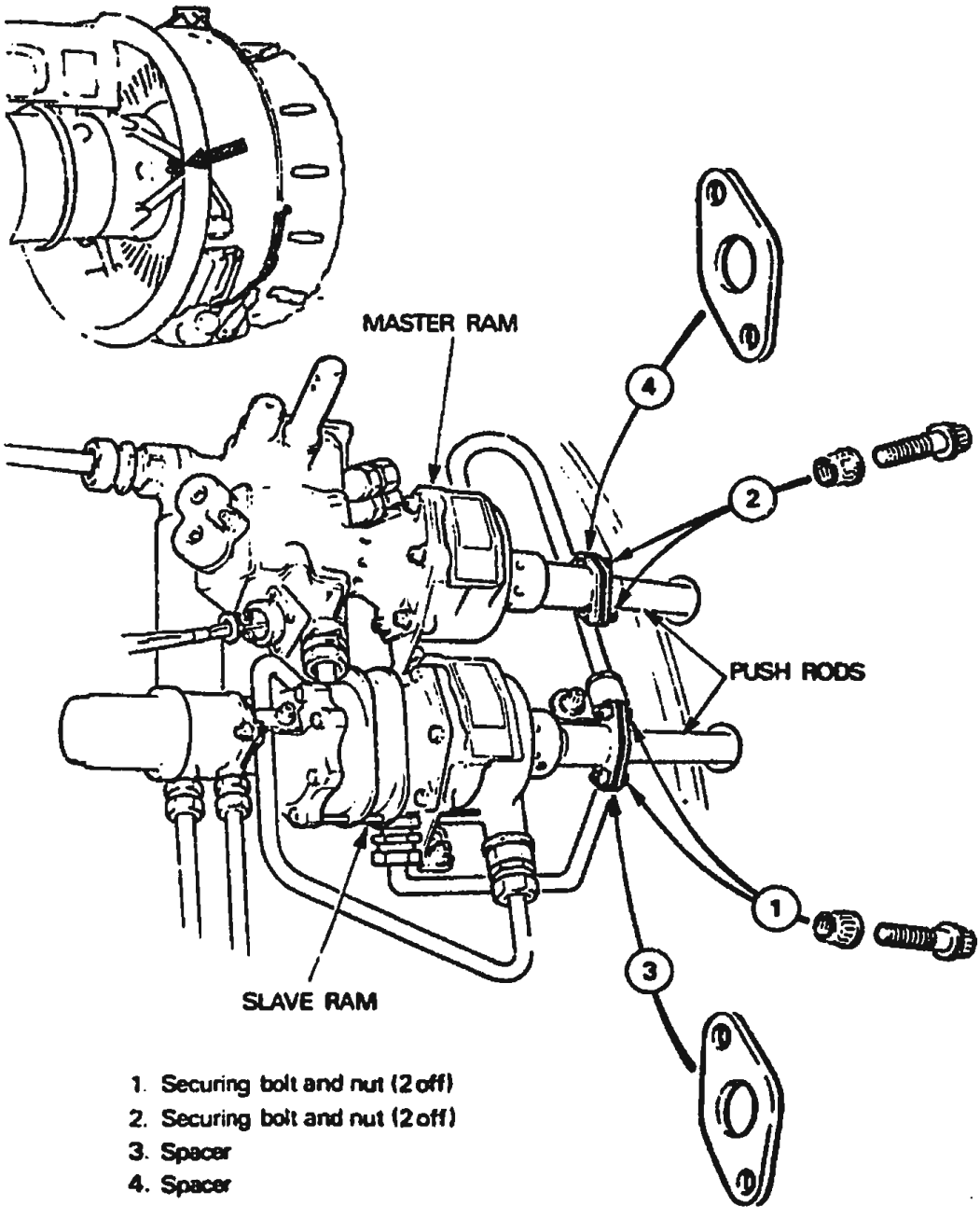
(4) Select spacer equal to dimension AE1.

(5) Bond spacer to slave ram push rod as detailed in operation M.

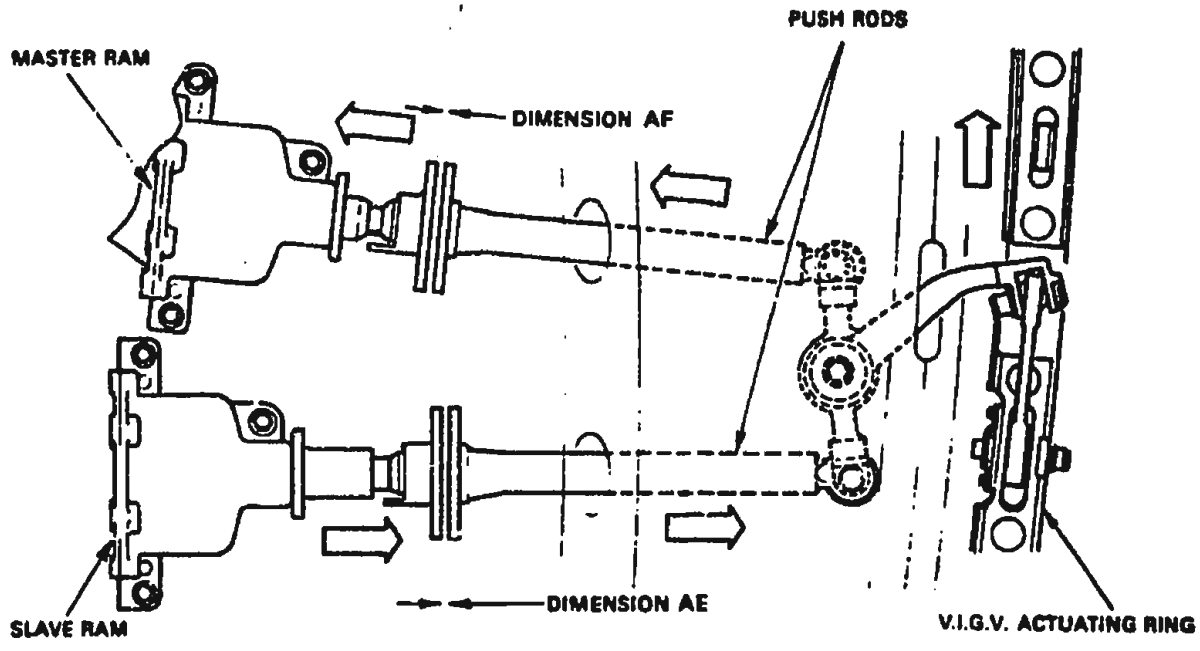
L. Set master ram linkage.

(1) Refer to fig.502, take up all movement in master ram, push rods and V.I.G.V. in direction of arrows.

(2) Measure and record dimension AF.




V.I.G.V. push rod disconnect points
Fig.501




V.I.G.V. operating linkage setting
Fig.502

CR (3) Subtract .008 to .016in. from dimension AF and record as dimension AF1.

On master ram incorporating Plessey S.B. I.G.V. 75-10 (Mod.2119; MR.102 Mk2 - see Ram Data Plate) - subtract
CR .035 to .043 inch. from dimension AF and record as dimension AF1.

(4) Select spacer equal to dimension AF1.

(5) Bond spacer to master ram push rod as detailed in operation M.

M. Bond spacer to push rod

(1) Prepare bonding agent (equal parts Araldite AV100 and HV100).

(2) WARNING: WHEN USING DEGREASING FLUID, AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Using degreasing fluid, clean push rod spigot and bore of spacer and allow to dry.

(3) Coat bore of spacer and spacer location point on spigot with bonding agent.

(4) Fit spacer to push rod spigot, ensuring correct alignment of bolt holes.

NOTE: Adhesive must be contained within width of spacer and must not contact mating faces of push rod or spacer.

N. Refer to fig.501, bring mating flanges of rams and push rods into abutment then fit and secure nuts and bolts (1) and (2).

P. Fit compressor section right-hand front gas generator fairing (Ref. 72-03-00, Removal/Installation).

Q. Remove working platform from cold stream duct.

R. Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00, Servicing).

# L.P. COMPRESSOR CASE AND VANES - INSPECTION/CHECK

## 1. Inspection

Service Bulletin referred to:

72-2514 - L.P. Compressor Outlet Guide Vanes - Deletion of Corrugated Strip

Referenced Procedures

| | |
|---|---|
| 6-40-00 | Exterior Access Doors and Removable Panels - Description and Operation |
| 6-50-00 | Interior Access Doors and Removable Panels - Description and Operation |
| 71-11-00 | Cowling, Engines No.1 and No.3 - Servicing |
| 71-12-01 | L.H. and R.H. Lower Hinged Cowls - Servicing |
| 71-12-05 | L.H. and R.H. Upper Hinged Cowls - Servicing |
| 72-31-01 | L.P. Compressor Case and Vanes - Cleaning/Painting |
| 72-31-01 | L.P. Compressor Case and Vanes - Approved Repairs |
| 78-30-00 | Thrust Reverser - Servicing |

A. Inspect L.P. Compressor Case

(1) No.1 or 3 engines

(a) Open left and right-hand hinged cowls 413A/423A and 414A/424A (Ref. 71-11-00).

(2) No.2 engine

(a) Open left and right-hand upper hinged cowls, 433DL/434DR (Ref. 71-12-05).

(b) Open left and right-hand lower hinged cowls, 433AL/434AR (Ref. 71-12-01).

(3) Inspect following for cracks and reject if cracked

(a) Front case front flange and runout to case.

(b) Rear case rear flange and runout to case.

(c) Case ring webs adjacent to front mount support links.

(d) Case boss adjacent to front mount centre support link spherical bearing housing.

(e) Clevis mounting bracket bosses and adjacent case.

(f) High-speed external gearbox clevis mounting brackets, also for security of attachment.

(4) L.P. Compressor Rear Case

(a) Inspect the rear case outer skin resistance, weld loops and adjacent outer skin for cracks.

(b) Refer to figs.602, 603 cracks in the left, right or lower sector resistance weld loops or adjacent outer skin not exceeding 3in. (76,2 mm.) - Repair (Ref. 70-42-26, FRS.3255).

(c) Cracks exceeding 3in. (76,2 mm.) - Reject and quarantine pending repair scheme investigation.

(d) Cracks in the upper sector - Reject and quarantine pending repair scheme investigation.

(e) Inspect the rear flange

(i) Front face gouged, scored or damaged up to 0.025in. (0,06 mm.) in depth - Repair FRS.3253 (Ref.70-42-11).

(ii) In excess of (i) - Reject

(5) No.1 and 3 engines

(a) Close left and right-hand hinged cowls, 413/423A and 414A/424A (Ref. 71-11-00).

(6) No.2 engine

(a) Close left and right-hand upper hinged cowls, 433DL/434DR (Ref. 71-12-05).

(b) Close left and right-hand lower hinged cowls, 433AL/434AR (Ref. 71-12-01).

B. Inspect L.P. Compressor Outlet Guide Vanes

(1) Equipment required:

| | |
|---|---|
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |

(2) WARNING: ENSURE THAT THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref. 78-30-00).

(3) Position working platform in cold stream duct.

(4) Refer to fig.601, enter cold stream duct, clean (Ref. 72-31-01, Cleaning/Painting) and inspect the following:

(a) L.P. compressor outlet guide vanes for cracks and holes particularly in areas within 6.0in. (152,40 mm.) of vane root and tip.

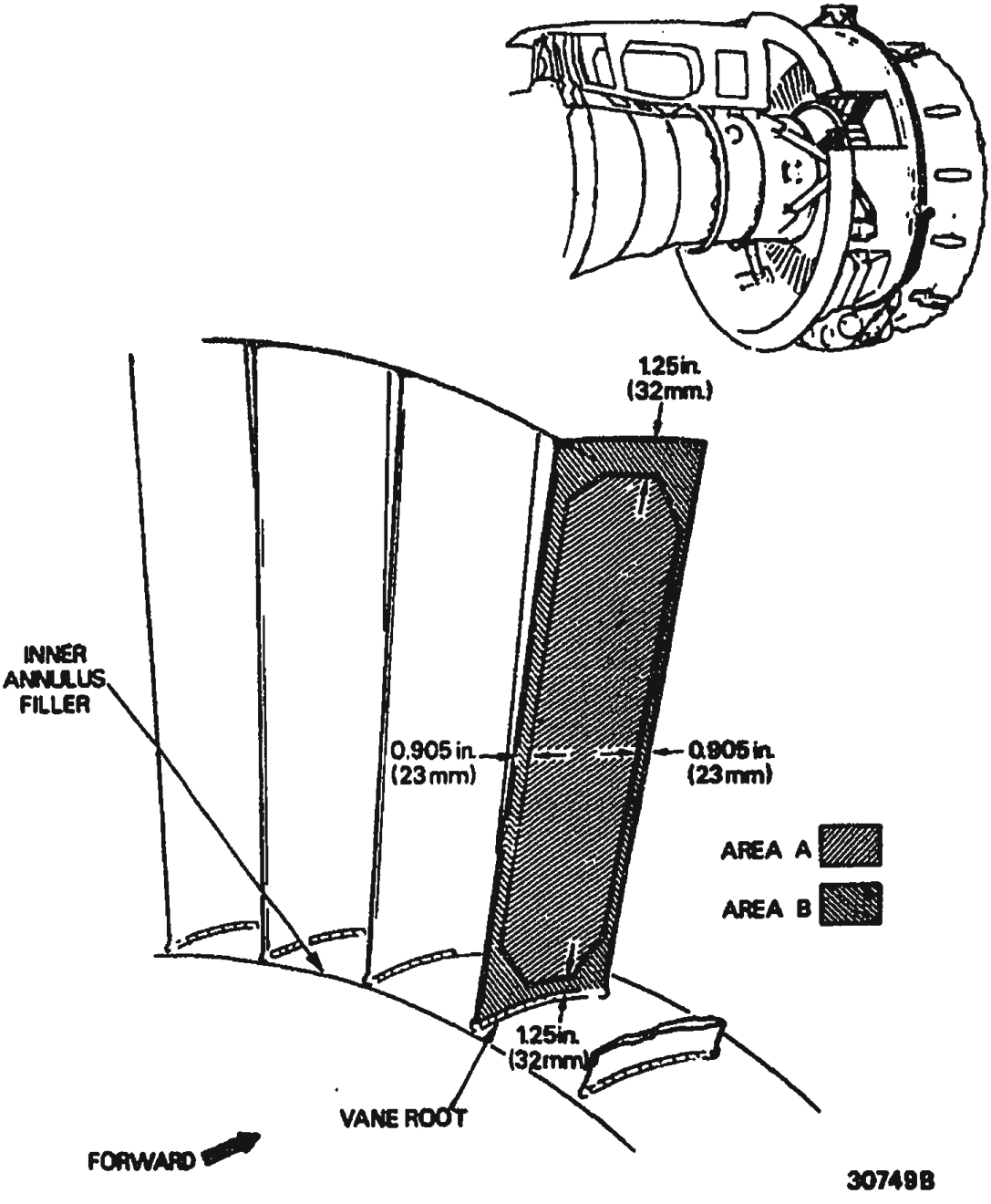
(b) L.P. compressor outlet guide vanes for corrosion.

(c) Outlet guide vane inner annulus filler for cracks and loose or missing pieces.

(d) Outer guide vanes (O.G.V.s) for evidence of birdstrike. If there is evidence of birdstrike on any O.G.V. (e.g. bird remains visible), then the affected O.G.V.s must be fluorescent penetrant inspected for cracks in accordance with O.P.213 In T.S.D.594-J.

(i) If the inspection cannot be accomplished immediately it is permissible to fly-on until the earliest opportunity when the inspection can be completed, which must be within 1,000 hours.

(5) For acceptance standards see 1. C.




L.P. compressor outlet guide vane inspection/check
Fig.601

(6) Remove working platform from cold stream duct.

(7) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00).

C. *Acceptance Standards*

(1) Cracking of L.P. compressor outlet guide vanes.

(a) On engines not incorporating S.B.72-2514, any cracks or holes in area A (Ref. Fig.601) that are within repair limits must be repaired at the first opportunity in accordance with FRS.3583 (Ref. 72-31-01, Approved Repairs).

NOTE: In assessing total crack length, the maximum dimension of each previously repaired area must be included. Therefore the sooner a crack is repaired the greater the allowable subsequent cracking before the assembly is rejected for exceeding the cumulative limits.

On engines incorporating S.B.72-2514, any cracks or holes in area A that are within repair limits must be repaired in accordance with FRS.3551 (Ref. 72-31-01, Approved Repairs).

(b) Any cracks in area B (Ref. Fig.601) that are within limits given in Table 601 must be closely monitored and repaired at the first opportunity in accordance with FRS.3551 (Ref. 72-31-01, Approved Repairs).

(c) Damage to vanes outside the repair limits of FRS.3551 and FRS.3583 may be repaired in accordance with FRS.3695 (Ref. 72-31-01, Approved Repairs).

Fly-on limit

C After repair to FRS.3695, advise MCIEE to place
C repair on watch; condition to be monitored each
C CK C.

Crack length assessment

NOTE: An axial crack is defined as one whose direction is between the vane leading and trailing edge. A radial crack is defined as one whose direction is between the vane root and tip.

(i) A truly axial crack - The critical length of a truly axial crack is the actual length of the crack.

(ii) A truly radial crack - The critical length of a truly radial crack is calculated as 25 per cent of the actual length of the crack.

(iii) Any other crack - The critical length of any other crack is calculated by measuring the projection of the crack in the axial direction, i.e. the axial distance between its ends.

Any cracks in any area of the vane in excess of the limits given in Table 601 are not acceptable.

| Position (Ref. Fig.602) | Max. number of cracked vanes | Total sum of critical crack lengths |
|---|---|---|
| Upper sector | 5 ( Max. of 3 adjacent vanes cracked | 12in. (304,8 mm.) |
| Lower sector | 5 | 12in. (304,8 mm.) |
| L.H. and R.H. sectors | 15 ( Max. of 10 cracked vanes in one sector | 45in. (1143 mm.) |
| Max. total | 20 | 60in. (1524 mm.) |

Table 601

(d) Damage to vanes, outside the repair limits of FRS.3551, FRS.3583 and FRS.3695 (Ref. 72-31-01, Approved Repairs) such that the vane is split open and is blocking adjacent air passages, or is severely damaged or cracked so that a large section may be released. In this instance it is permissible for the engine to remain in service with the damaged vane removed in accordance with the following procedure paragraphs (e) to (m), for either:

(i) 125 hours or 25 flights, provided that damage to other vanes is within the acceptance limits of paragraphs (a) and (b).

(ii) Indefinitely, provided the affected vane is not in the upper sector of vanes (Refer to Fig.602) and all other vanes are crack free and inspected for cracks at intervals not exceeding 300 hours. If any vanes are found cracked the engine must be removed within 125 hours or 25 flights, for repair.

NOTE: 1. Inspection of the 4 vanes adjacent to the removed vane is to be by local penetrant. The remaining vanes may be inspected visually.

2. Affix an informational placard to the aircraft logbook advising the engine position, description of the condition, and the Maintenance Manual reference when operating with a missing vane(s). Remove placard when condition is corrected. Advise MCIMD/MCIEE.

(e) WARNING: ENSURE THAT THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILST WORK IS IN PROGRESS
Deactivate and tag thrust reverser and associated systems and fit thrust reverser mechanical locks (Ref. 78-30-00).

(f) Position working platform in cold stream duct.

(g) Remove the two securing setscrews or cut the vane through as close as possible to the outer/tip weld.

(h) Cut through the inner/root end of the vane at a position between 0.5in.(12,7 mm.) and 1.0in. (25.4 mm.) from the inner/root weld and remove the vane.

NOTE: This will ensure sufficient vane stub remains to enable subsequent repair to FRS.3580.

(i) Only one vane in the assembly is to be removed.

(j) On/before completion of the above 'fly on' period the vane is to be replaced in accordance with Overhaul Manual 72-31-01, FRS.3580.

(k) Ensure that all loose material and debris is removed from the area.

(l) Remove work platform from cold stream duct.

(m) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00).

(2) Corrosion of L.P. Compressor Outlet Guide Vanes

(a) Refer to figs.601 and 602 Isolated corrosion holes up to 0.06in. (1.5 mm.) in diameter are acceptable in area A provided there are:

(i) Not more than 50 holes per vane side.

(ii) Not more than 250 holes per upper and lower sectors.

(iii) Not more than 300 holes per RH and LH sectors.

(b) When the density of corrosion is such that numerous holes occur within a 1 inch (25,4 mm.) circle, or isolated corrosion holes exceed 0.06in. (1,5 mm.) in diameter, then the following additional limits also apply.

(i) The sum of individual corrosion hole diameters within a circle up to 1in. (25,4 mm.) in diameter must not exceed 0.39in. (10 mm.).

(ii) Individual holes must not exceed 0.39in. (10 mm.) in diameter.

(iii) Groups of holes or holes in excess of 0.06in. (1,5 mm.) diameter must be separated by at least 1in. (25,4 mm.) with no isolated corrosion occurrence in between.

(iv) The number of holes in excess of 0.06in. (1,5 mm.) in diameter or any groups of holes must not exceed 5 occurrences per vane side, with no two axially adjacent.

(c) Vanes with corrosion in excess of the above limits must be replaced within 125 hours or 25 flights which ever is the sooner.

(d) Refer to fig.601 Corrosion holes in area B are not acceptable and all affected vanes must be replaced within 125 hours or 25 flights whichever is the sooner.

(e) All affected vanes found to be within the limits given above must be re-inspected at intervals not exceeding 500 hours.

(3) Outlet guide vane inner annulus filler.

(a) Cracks, providing no pieces are loose or missing.

(b) Pieces loose or missing, repair in accordance with FRS.3551, parts F and G (Ref. 72-31-01, Approved Repairs).

D. Inspect L.P. Compressor Case Attrition Lining

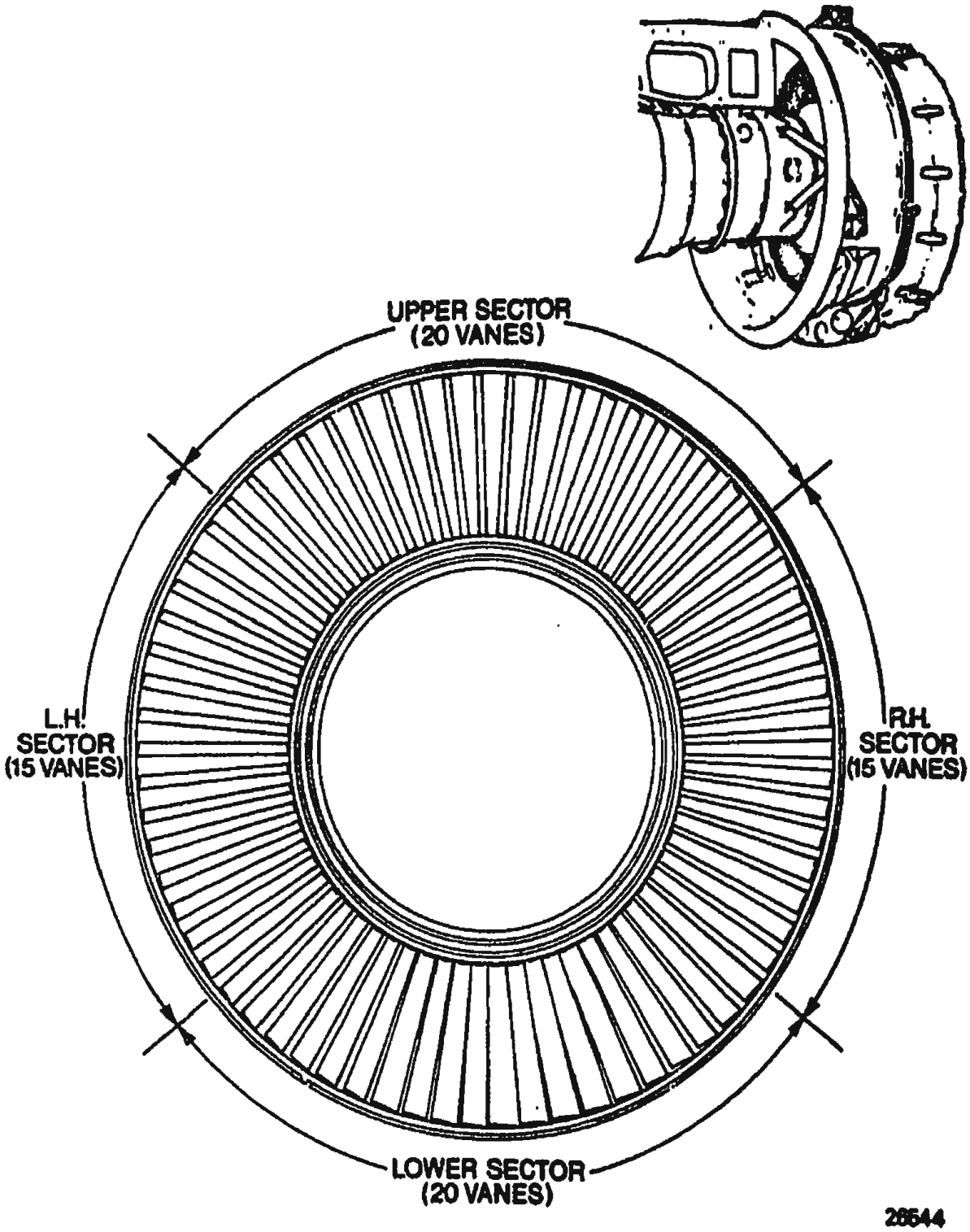
WARNING: TO PREVENT L.P. COMPRESSOR WINDMILLING, FIT HOT AND COLD STREAM OUTLET BLANKS.

R NOTE: For fitting and removal of hot and cold stream outlet
R blanks. (Ref.71-00-00, Cleaning, Painting and
R Preservation).

(1) Equipment required:

| | |
|---|---|
| 289200 or C 4G 4342 | Protective work mats |
| XUT.40959 | Nose cowl work platform |

(2) No.1 and 3 engines: position protective work mats or work platform in nose cowl air intake ensuring red warning pennants are clearly visible from aircraft exterior.




L.P. compressor outlet guide vane positional definition
Fig.602

(3) No.2 engine: open access doors 433BL (Ref. 6-40-00) and 431AZ (Ref. 6-50-00) and position protective work mats in air intake ensuring red warning pennants are clearly visible from aircraft exterior.

(4) Enter air intake and inspect attrition lining for L.P. compressor blade tip rub, damage and circumferential scoring.

For acceptance standards see 1. E.

(5) No.1 and 3 engines: remove protective work mats or work platform from nose cowl air intake.

(6) No.2 engine: remove protective work mats from air intake and close access doors 431AZ (Ref. 6-50-00) and 433BL (Ref. 6-40-00).

E. Acceptance Standards

(1) Blade tip rub

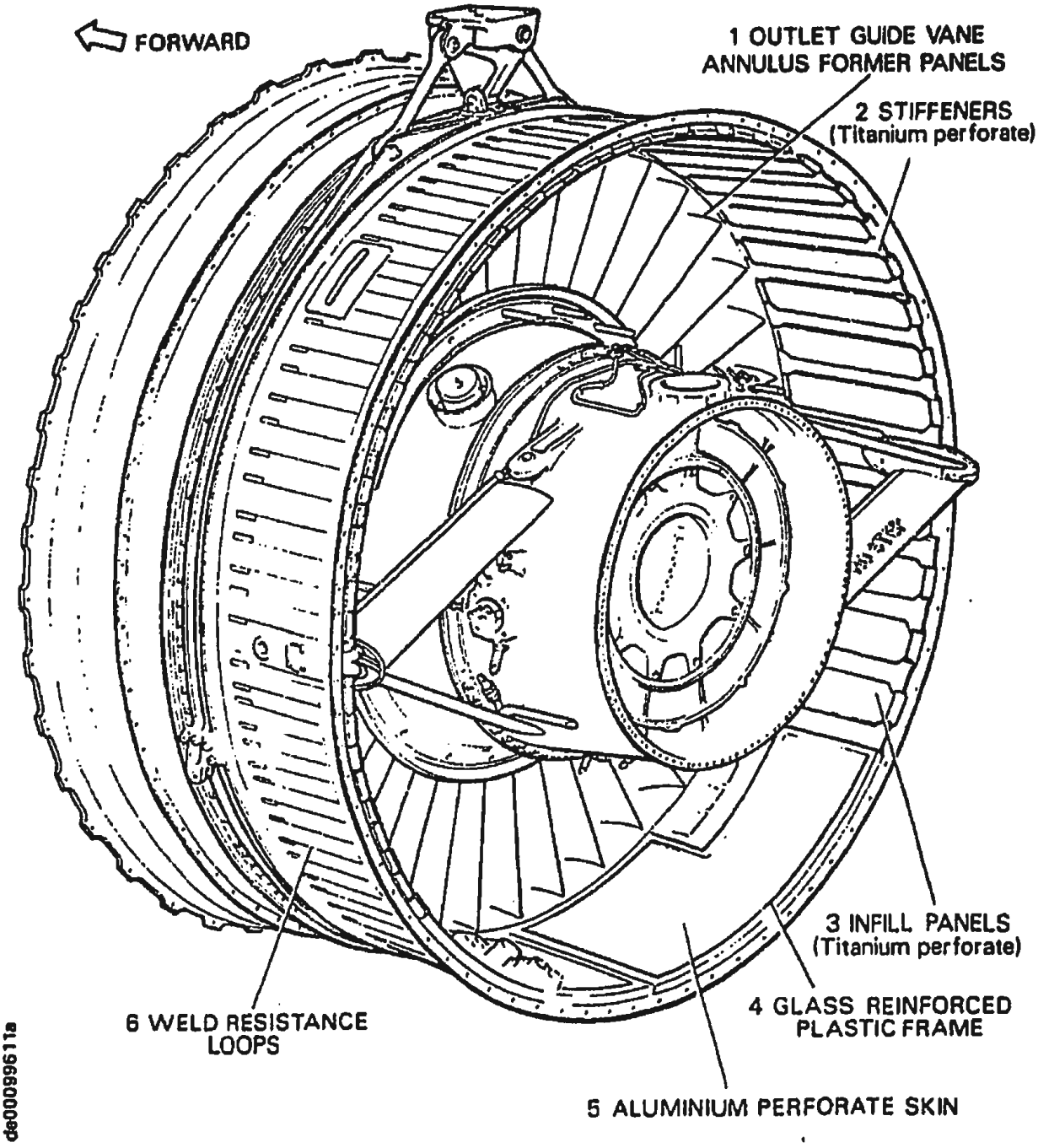
To a maximum depth of 0.1in. (2.54 mm.) in lining on L.P. compressor blade tip path.

Dress rear step of rub over an axial length of 10 to 15 times the step depth to blend into annulus, ensuring the blending is separated by a minimum of 0.5in. (12.7 mm.) from glass reinforced plastic (G.R.P.) ice impact panel.

(2) Erosion of filled honeycomb front and rear of fan rotor path.

(a) Erosion of the honeycomb and/or filler may extend to a depth of 0.2in. (5,08 mm.)

(b) Erosion in excess of this must be repaired in accordance with FRS.3428 (Ref. 72-31-01, Approved Repairs).




R L.P. compressor case acoustic linings inspection/check
R Fig.603

(3) Damage

Damage may extend to full depth of attrition lining for the following:

(a) A total of five areas of damage whose maximum dimensions do not exceed 3.00in. (76,20 mm.) in any one direction, providing they are separated by at least 4.00in. (101,60 mm.) of sound lining.

(b) Any number of damaged areas whose maximum dimensions are less than 2.00in. (50,80 mm.) providing they are separated by at least 4.00in. (101,60 mm.) of sound lining.

(c) Damage in excess of that in (a) and (b) above:-

R (i) May fly-on only for the minimum number of
R flights necessary to effect repair at the
R earliest opportunity.

R (ii) Fan disc and blade exposure recording procedure

Whenever an occurrence of damage in excess of limits in (a) and (b) is reported from the sector described by the top 20 O.G.V's the following details must be recorded against the serial number of the fan disc and each fan blade installed in the engine at that time.

R (iii) Cyclic life of the disc and each blade when such damage is first reported.

(iv) The number of flight cycles accumulated on the disc and each blade while exposed to the above damage.

CAUTION: IN THE EVENT THAT FAN BLADES AND DISCS ARE EXPOSED TO A CUMULATIVE TOTAL OF 100 OR MORE FLIGHT CYCLES WITH FAN ATTRITION LINING DAMAGE IN EXCESS OF LIMITS IN (a) AND (b) IN THE SECTOR DESCRIBED BY THE TOP 20 O.G.V'S, THEN A REDUCTION IN THE DECLARED CYCLIC LIFE WILL BECOME EFFECTIVE AND ROLLS-ROYCE SHOULD BE INFORMED TO ENABLE THE REDUCTIONS TO BE ASSESSED.

IT IS IN THE OPERATORS INTEREST TO REPAIR DAMAGE AT THE EARLIEST OPPORTUNITY THUS REDUCING FAN BLADE AND DISC EXPOSURE AND CONSERVING THE 100 FLIGHT CYCLES CUMULATIVE TOTAL.

(4) Circumferential scores

Scores of any length providing that the lining around them is sound.

F. Inspect L.P. Compressor Rear Case Acoustic Linings

(1) Equipment required:

| | |
|---|---|
| CP.20309 or XUT.37594 | Working platform |
| or (XUT.42526 | Spacer |
| (XUT.42527 | Side piece |

(2) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref. 78-30-00).

(3) Position working platform in cold stream duct.

(4) Refer to fig.603, enter cold stream duct and inspect the following:

(a) Stiffener titanium perforate skins for security, cracks, dents and scores. Lifting of bonded surfaces is not acceptable.

(b) Infill panels titanium perforate skin for security, cracks, dents and scores. Lifting of bonded surfaces is not acceptable.

(c) Aluminium perforate skins for cracks, dents and scores.

(d) Glass reinforced plastic (G.R.P.) frames for delamination, frettage, chafing and nicks. Delamination of frames is not acceptable.

R (e) Outlet guide vane infill panels for security, cracks, dents and scores.

For acceptance standards see 1. G.

(5) Remove working platform from cold stream duct.

(6) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00).

G. Acceptance Standards

(1) Stiffener titanium perforate skins

(a) Cracks up to 2.00in. (50,80 mm.) in length provided they do not extend to stiffener edges.

(b) Smooth dents up to a depth of 0.150in. (3,81 mm.) provided the dent does not exceed 2.00in. (50,80 mm.) in length and does not encroach the infill panel surfaces.

(c) Scores up to 10 per cent of the material thickness in depth and not exceeding 2.00in. (50,80 mm.) in length.

(d) Damage that is within repair limits may be repaired in accordance with FRS.3429 (Ref. 72-31-01, Approved Repairs)

(2) Infill panels titanium perforate skins

(a) Cracks up to 2.00in. (50,80 mm.) in length provided they do not extend to panel edges.

(b) Smooth dents up to a depth of 0.10in. (2,54 mm.) provided the dent does not exceed 2.00in. (50,80 mm.) in length and does not encroach the bonded areas.

(c) Scores up to 10 per cent of the material thickness in depth and not exceeding 2.00in. (50,80 mm.) in length.

(d) Damage that is within repair limits may be repaired in accordance with FRS.3429 (Ref. 72-31-01, Approved Repairs).

(3) Aluminium perforate skins

(a) Cracks up to 0.50in. (12,70 mm.) in length provided they do not extend to panel edges.

(b) Smooth dents up to a depth of 0.15in. (3,81 mm.) and not exceeding 2.00in. (50,80 mm.) in length.

(c) Scores up to 14 per cent of the material thickness in depth and not exceeding 2.00in. (50,80 mm.) in length.

(d) Damage that is within repair limits may be repaired in accordance with FRS.3429 (Ref. 72-31-01, Approved Repairs).

(4) Glass reinforced plastic (G.R.P.) frames

(a) Frettage and chafing through a maximum of two laminations provided the damaged area is sealed with air curing resin sealer.

(b) Nicks are acceptable provided the exposed glass is sealed with air curing resin sealer.

R (5) Outlet guide vane annulus former panels

(a) Cracks up to 0.50in. (12,70 mm.) in length provided they do not extend to panel edges.

(b) Smooth dents up to a depth of 0.15in. (3,81 mm.) and not exceeding 2.00in. (50,80 mm.) in length.

(c) Scores up to 14 per cent of the material thickness in depth and not exceeding 2.00in. (50,80 mm.) in length.

R NOTE: If O.G.V. annulus former panels are missing, or pieces from infill panels are missing, inspect I.D.G. oil cooler air inlet for blockage.

C H. Inspect L.P. Compressor Case Torsion Box to Gas Generator
C Fairing seal

C (1) Equipment required:

C CP.20309 or XUT.37594 Working platform
C or (XUT.42526 Spacer
C (XUT.42527 Side piece

C WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN
C FORWARD THRUST POSITION WHILE WORK IS IN
C PROGRESS.

C (2) Deactivate and tag thrust reverser and associated
C systems, and fit thrust reverser mechanical locks
C (Ref.78-30-00).

C (3) Position working platform in cold stream duct.

C (4) Remove gas generator fairings (Ref.72-03-00) as
C necessary to gain access to seal.

C (5) Inspect seal for damage and torn areas or lifting of
C bonding.

C For acceptance standards see 1.I.

C (6) Remove working platform from cold stream duct.

C (7) Unlock and reactivate thrust reverser and associated
C systems (Ref.78-30-00).

C I. Acceptance Standards

C (1) Rubber Seal

C (a) Cuts, tears and damage to seal surface, limited to
C 20 percent missing across the face of any one gas
C generator fairing, permissible on maintenance checks
C lower than Check 'C'.

C (b) Seal must be maintained on all maintenance checks,
C Check 'C' or higher. Replace seal in accordance
C with 72-31-01 "Renew or Rebond Fairing Rubber Seal".

R J. Inspect Front Case Acoustic Linings.

R WARNING: TO PREVENT L.P. COMPRESSOR WINDMILLING, FIT HOT
R AND COLD STREAM OUTLET BLANKS.

R NOTE: For fitting and removal of hot and cold stream outlet
R blanks. (Ref.71-00-00, Cleaning, Painting and
R Preservation).

R (1) Equipment required:

| | | |
|---|---|---|
| R | 289200 or C4G4342 | Protective work mats |
| R | XUT40959 | Nose cowl work platform |

R (2) No.1 and 3 engines: position protective work mats or
R work platform in nose cowl air intake ensuring red
R warning pennants are clearly visible from aircraft
R exterior.

R (3) No.2 engine: open L.H. hinged cowl 433AL (Ref.6-40-00)
R and 431AZ (Ref.6-50-00) and position protective work
R mats in air intake ensuring red warning pennants are
R clearly visible from aircraft exterior.

R (4) Refer to fig.604, enter air intake and inspect acoustic
R linings for:

R CAUTION: ENSURE ACOUSTIC LINING SURROUNDING THE DAMAGED
R AREA(S) IS INTACT. ANY LOOSE MATERIAL SHOULD
R BE REMOVED.

R (a) Lifting of bonded surfaces

R (b) Damaged panels

R (c) Loose or detached panel edge sealing strips.

R (d) Loose or missing panels.

R For acceptance standards see 1.J.

R (5) No.1 and 3 engines: remove protective work mats or work
R platform from nose cowl air intake.

R (6) No.2 engine: remove protective work mats from air intake
R and close access doors 431AZ (Ref.6-50-00) and 433AL
R (Ref.6-40-00).

R K. Acceptance Standards

R (1) Acoustic panels (aluminium perforate).

R (a) Lifting of bonded surfaces.

R (i) Lifting up to 4.0in. (101,6 mm.) in axial
R length from the trailing edge - Accept subject
R to fly on limit.

R (ii) Fly on limit - Engine with lifting of bonded
R surface accepted in (i) may fly on for a
R maximum of 1000 hours or the next convenient
R aircraft maintenance inspection, whichever is
R soonest. Repair in accordance with FRS3429
R (Ref.72-31-01, Approved Repairs).

(b) Dents

(i) Smooth dents up to 4.0in. (101,6 mm.) in length.

(c) Cracks

(i) Cracks up to 1.0in. (25,4 mm.) in length provided they do not extend to panel edges.

(d) Holes

(i) One hole on a panel provided its maximum dimension does not exceed 2.0in. (50,8 mm.) in any direction.

(ii) Three holes on a panel provided no dimension exceeds 1.0in. (25,4 mm.) in any direction.

(e) Scores

(i) Scores up to 2.0in. (50,8 mm.) in length.

(f) Damage in excess of above:

R (i) Damage in excess of (b) to (e) inclusive, but not exceeding 50 per cent of any panel area, provided that there is no debond in the surrounding area - accept subject to fly-on limit in (ii).

R (ii) Fly-on limit - engine with damage accepted in (i) may fly-on for a maximum of 1000 hours provided that any loose material is removed and that the area is inspected for debond at intervals not exceeding 300 hours. Before the 1000 hours limit is reached, or at the earliest opportunity, the panels must be repaired in accordance with FRS3429, (Ref.72-31-01, Approved Repairs).

(iii) Damage in excess of (i) repair in accordance with FRS3429 (Ref.72-31-01, Approved Repairs).

(g) Loose or detached panel edge sealing strips - Accept.

(h) Loose or missing panels

(i) It is acceptable to fly-on for a maximum of 125 hrs/25 flights with one acoustic panel missing, provided that blue filler is applied to the edges of the adjacent remaining panels in accordance with FRS1127 (Ref.72-31-01, Approved Repairs).

NOTE: This fly-on limit does not cover loss of material from the ice impact area.

If FRS1127 cannot be accomplished immediately, it is acceptable to fly-on to a location where it can be applied.

(ii) In excess of (i) - Reject.

(2) Ice impact area

(a) Damage or erosion to coating.

(i) Damage or erosion to coating provided the GRP underneath is not penetrated - Accept

(b) Damage to GRP ice impact area

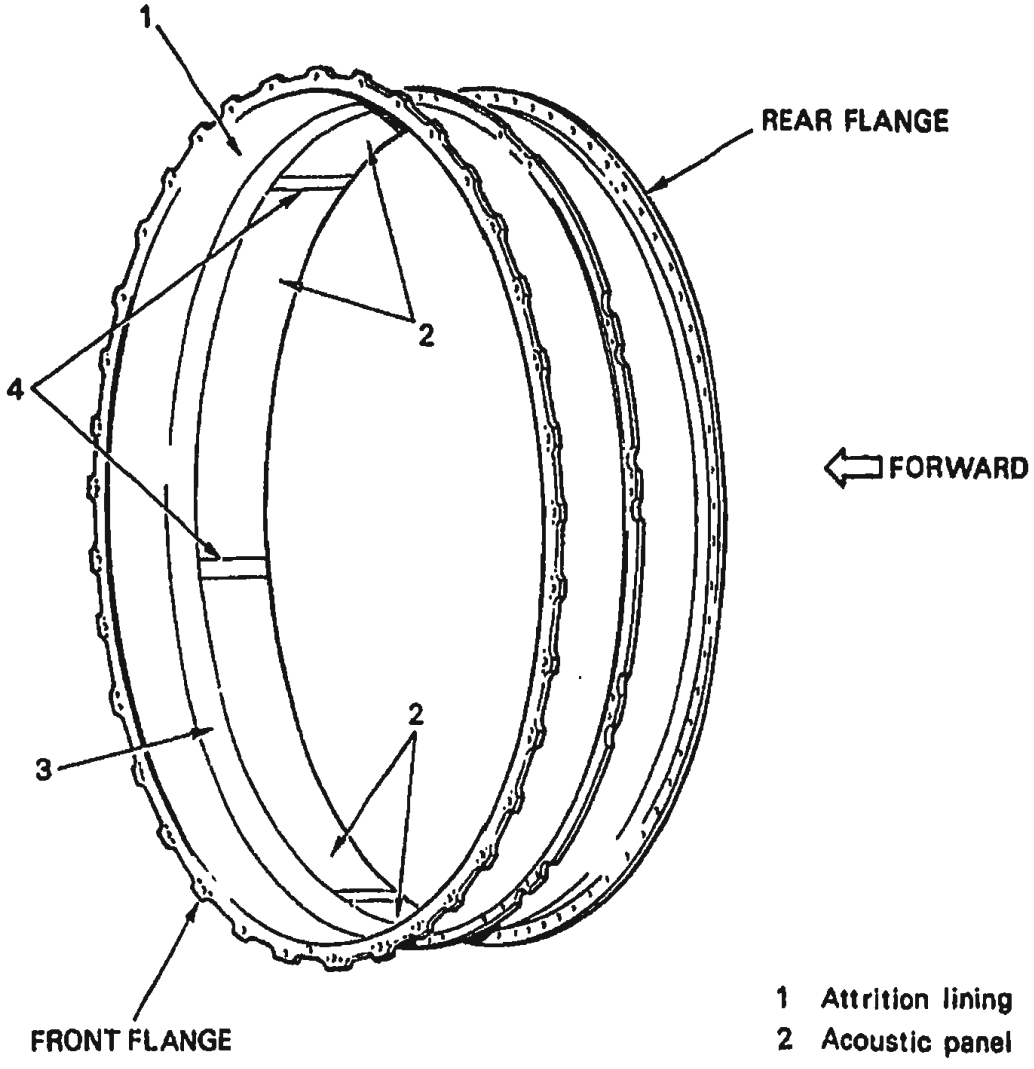
(i) Ice shedding or general peppering damage causing penetration of the ice impact area up to a total of 10 percent circumferential area and a maximum of 30 percent of any one panel - Repair in accordance with FRS5141 (Ref.72-31-01, Approved Repairs), within 1,000 hours maximum or at next convenient aircraft maintenance inspection whichever is soonest.

R

(ii) Damage in excess of the limits in (i) causing penetration of the ice impact area up to a total of 30 percent circumferential area and a maximum of 30 percent of any one panel - Repair in accordance with FRS5141 (Ref.72-31-01, Approved Repairs), within 250 hours maximum or at next convenient aircraft maintenance inspection whichever is soonest.

R
R

(iii) Damage in excess of the limits in (ii) - Reject within 125 hours maximum.




A2910

L.P. compressor front case acoustic lining - Inspection/Check
Fig.604

## L.P. COMPRESSOR CASE AND VANES - CLEANING/PAINTING

### 1. Clean L.P. Compressor Outlet Guide Vanes

WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD POSITION (REF. 78-30-00, SERVICING) WHILE WORK IS IN PROGRESS.

Two method of cleaning are detailed. Either may be used.

A. Method 1

(1) Equipment required:

CP.20309 or XUT.37594 Working platform

(2) Material required:

| | | OMat Item No. |
|---|---|---|
| Cleaning fluid | - | 1070 |
| Demineralized water | | |

(3) Tag throttle levers and thrust reverser levers. Tag APU/GND AIR TO REVERSER switches.

(4) Open and tag appropriate THRUST REVERSE circuit breaker on pilot's overhead circuit breaker panel CB1, zone 210.

(5) Open and tag appropriate START AIR VALVE circuit breaker on Flight Engineer/Second Officer's aft circuit breaker panel CB3, zone 215.

(6) Tag appropriate ENGINE START panel switchlights.

(7) Position working platform in cold stream duct.

R (8) WARNING: WHILST THE WASHING FLUIDS USED IN THE
R FOLLOWING PROCEDURES ARE NON-FLAMMABLE AND
R NON-TOXIC THEY ARE IRRITANTS. PRECAUTIONS
R SHOULD BE TAKEN IN ACCORDANCE WITH WASHING
R FLUID MANUFACTURERS INSTRUCTIONS.

Prepare a solution using a ratio by volume of 4 parts demineralised water to 1 part cleaning fluid. Thoroughly agitate until emulsified.

R NOTE: Demineralised water may have a maximum conductance
R of 20 microsiemens.

NOTE: If left for more than 30 minutes after mixing, re-agitate mixture.

(9) Enter cold stream duct and wipe vanes with clean cloth or soft bristle brush moistened with the mixture.

(10) Wipe vanes dry with clean cloth.

(11) Remove working platform from cold stream duct.

(12) Remove tags and close circuit breakers opened in operations (3) through (6).

B. Method 2

(1) Equipment required:

CP.20309 or XUT.37594 Working platform

(2) Material required:

Degreasing fluid

| | | |
|---|---|---|
| British Spec: | BS.4487 (1969) | (Chlorothene NU<br>(Inhibisol<br>(Genklene |
| | DEF TS 367<br>BS.4487 (1969) | (Chlorothene VG<br>(Genklene LV |
| American Spec: | Mil-T-81533 | Chlorothene VG |

WARNING: SMOKING MUST NOT BE ALLOWED WHEN USING DEGREASING FLUIDS AS THE VAPOUR DECOMPOSES TO FORM PRODUCTS WHICH ARE EXTREMEMLY TOXIC.

WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALATION OF VAPOUR

(3) Effect operations A. (3) through (7).

(4) Enter cold stream duct and wipe vanes with clean cloth moistened with degreasing fluid.

(5) Effect operations A. (11) and (12).

# L.P. COMPRESSOR CASE AND VANES - APPROVED REPAIRS

## LIST OF REPAIRS


| | Repair No. | Title | Page No. |
|---|---|---|---|
| | FRS.3583 | Repair cracked outlet guide vanes by locally filling with light weight filler | 803 |
| | FRS.3551 | Repair cracked outlet guide vanes by direct welding | 809 |
| | FRS.3429 | Local repair of acoustic lining | 819 |
| | FRS.3695 | Restore aerodynamic shape of vane when a piece has broken out (7 vanes maximum) | 825 |
| | FRS.3428 | Local repair of attrition lining | 829 |
| | FRS.3579 | Repair the ice impact area surface coating | 835 |
| | FRS.4686 | Repair of Attrition Lining | 840 |
| R | FRS.5141 | Repair dents in ice impact panel | 847 |
| R R R | FRS.1127 | Missing Acoustic Panels - Restoration of Aerodynamic Smoothness | 851 |

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# L.P. COMPRESSOR OUTLET GUIDE VANES (O.G.V.) (Pre S.B.72-2514)

## REPAIR CRACKED VANES BY LOCALLY FILLING WITH LIGHT WEIGHT FILLER

## FRS.3583

This repair covers: Cracks in the brazed area of the vanes.

Associated Repair: FRS.3551, L.P. compressor outlet guide vanes (O.G.V.). Repair cracked vanes by direct welding

### 1. Effectivity

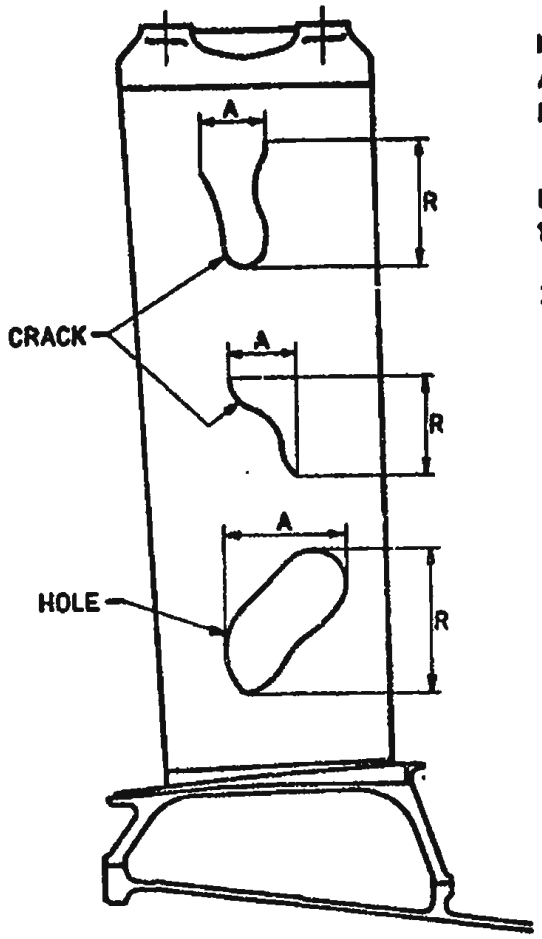
| I.P.C. Fig./Item | Part No. | | Assembly |
|---|---|---|---|
| 03 500 | LK.39559 | Pre S.B.72-2147 | A |
| | LK.43822 | S.B.72-2147 | A |
| | LK.46544 | S.B.72-2084 Part 1 | A |
| | LK.56483 | S.B.72-2084 Part 2 | A |
| | LK.47650 | S.B.72-2124 | A |
| | Deleted | | |

### R 2. General

R If the vane is not filled with microballoon, the entire vane
R must be filled in accordance with FRS.3551 before accomplishing
R this FRS. Vanes which have not had previous applications of
R microballoon may be welded within the limits of FRS.3551.

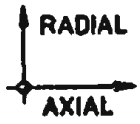
### R 3. Instructions

It is intended that this repair is carried out with the O.G.V. still situated in the O.G.V. casing.




NOMENCLATURE.
A = AXIAL PROJECTION OF CRACK LENGTH
R = RADIAL PROJECTION OF CRACK LENGTH

LIMITS.
1. SUM OF A'S ≤ 101,6 (4.000)
2. SUM OF A'S + $\frac{\text{SUM OF R'S}}{2}$ ≤ 127 (5.000)




VANE CRITICAL CRACK LENGTH
= SUM OF A'S + $\frac{\text{SUM OF R'S}}{2}$

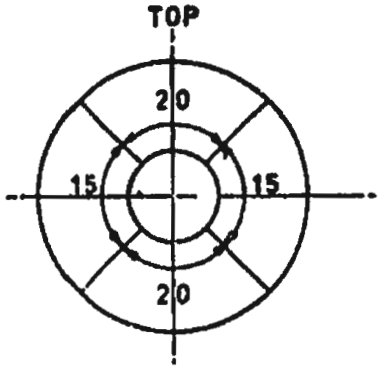
SECTION THROUGH VANES ASSEMBLY, OUTLET GUIDE, L.P. COMPRESSOR.

DIMENSIONS ARE IN MILLIMETRES WITH INCH CONVERSIONS IN PARENTHESIS

ACCEPTANCE LIMITS FOR INDIVIDUAL VANES. 41206A

R Repair details
R Fig.801

AMOUNT OF CRACKING ALLOWED TO BE REPAIRED BY FILLING.
1. TOTAL NUMBER OF CRACKED VANES ALLOWABLE PER ASSEMBLY. 25.
2. TOTAL CUMULATIVE CRACK LENGTH PER ASSEMBLY. 1524. (60.000).
3 POSITION AND NUMBER OF CRACKED VANES AS BELOW.




DIAGRAMMATIC VIEW OF VANES.

| TOP SECTION (20 VANES) | | |
|---|---|---|
| MAX NUMBER OF CRACKED VANES IN TOP SECTION. | MAX NUMBER OF CRACKED VANES ADJACENT IN TOP SECTION. | TOTAL ALLOWABLE CRACK LENGTH CUMULATIVE IN THE 5 ALLOWABLE CRACKED VANES. |
| 5 | 3 | 304,8 (12.000) |

| BOTTOM SECTION (20 VANES) | |
|---|---|
| MAX NUMBER OF CRACKED VANES IN BOTTOM SECTION. | TOTAL ALLOWABLE CRACK LENGTH CUMULATIVE IN THE 5 ALLOWABLE CRACKED VANES. |
| 5 | 304,8 (12.000) |

| SIDE SECTIONS (30 VANES 15-PER SIDE) | |
|---|---|
| MAX NUMBER OF CRACKED VANES | TOTAL ALLOWABLE CRACK LENGTH CUMULATIVE IN THE 15 ALLOWABLE CRACKED VANES |
| 15 VANES NOT MORE THAN 10 ON ONE SIDE | 1143 (45.000) |

DIMENSIONS ARE IN MILLIMETRES WITH INCH CONVERSIONS IN PARENTHESIS

ASSEMBLY ACCEPTANCE LIMITS. 41207A

R Acceptance limits (inches in parentheses)
R Fig.802

A. Prepare the Vane for Filling

| Procedure | Supplementary information |
|---|---|
| (1) Clean the vanes | Cold liquid degrease. |
| (2) Penetrant crack test to establish length of cracking | Refer to fig.802 for details of cracking limits. |
| (3) Cut out the crack or hole | See Fig.801<br>Tool: Powered hand tools<br>Holes must be dressed circular |
| (4) Deburr the exposed wiggle strip | |

B. Prepare the filler material EC3524 B/A

| Procedure | Supplementary information |
|---|---|
| R R R (1) Prepare the blue filler | T.S.D.594, O.P.707, Blue filler EC3524 B/A OMat 874 |

C. Fill the prepared slots in vane with filler material

| Procedure | Supplementary information |
|---|---|
| (1) Cold liquid degrease the areas to be filled | |

| | Procedure | Supplementary information |
|---|---|---|
| | (2) Press the filler material firmly into the cavity, ensuring it is keyed under the vane edges | See Fig.801<br>*Tool:* Clean warm palette knife or trowel |
| R R R | (3) Cure | T.S.D.594, O.P.707, Curing chart<br>Blue filler EC3524 B/A |
| | (4) Smooth the filler to the vane contour | Glass paper<br>Carry out immediately material is hard to touch. |
| | (5) Cold liquid degrease the repaired area | |
| | (6) Visually inspect | |
| | (7) Paint the exposed areas with high heat resisting enamel | See 70-42-12 |

R 4. Material of components

| | R.R. Symbol | Material |
|---|---|---|
| L.P. O.G.V. | EAK | 12 per cent chrome steel |
| Filler | | Epoxy Resin |

R 5. Parts required

Not applicable

R 6. Price and Availability

R Repair of spares - Refer to Rolls-Royce plc

# L.P. COMPRESSOR CASE AND VANES - APPROVED REPAIRS

## REPAIR CRACKED OUTLET GUIDE VANES BY DIRECT WELDING FOLLOWED BY FILLING WITH LIGHTWEIGHT FILLER

## FRS.3551

This repair covers:

Weld cracks in the weld at the inner end of vanes
Weld cracks in vanes
Repair filler

Associated Repairs

FRS.3583, L.P. compressor outlet guide vanes (O.G.V.) Repair cracked vanes by locally filling with lightweight filler

### 1. Effectivity

| I.P.C. Fig./Item | Part No. | |
|---|---|---|
| 03 500 | LK.39559 | Pre S.B.72-2147 |
| | LK.43822 | S.B.72-2147 |
| | LK.46544 | S.B.72-2084 |
| | LK.56483 | S.B.72-2084 Part 2 |
| | LK.47650 | S.B.72-2124 |
| | LK.51299 | S.B.72-2514 |

### 2. Deleted

### 3. Instructions

CAUTION: BEFORE WELDING ENSURE ADEQUATE FIRE PRECAUTIONS HAVE BEEN TAKEN.

To minimise distortion it is intended that this repair will be carried out with the O.G.V. still situated in the O.G.V. casing.

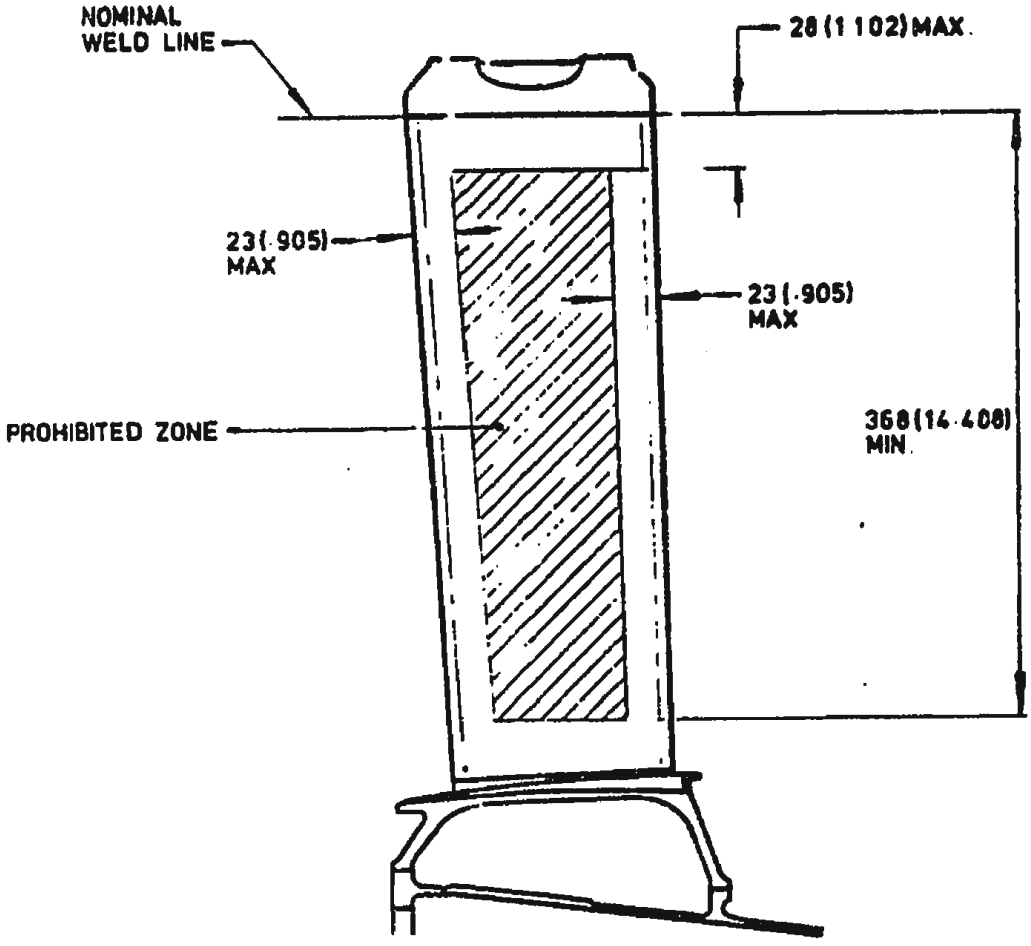
Welding is not to be carried out within 25,4 mm. (1.000in.) of panels bonded to fan case inner surface.

A. Prepare for welding

| Procedure | Supplementary information |
|---|---|
| (1) Clean the vanes | Cold liquid degrease |
| (2) Penetrant crack test to establish length of cracking | See fig.803 for repair limitations on Pre S.B.72-2514 standard vanes<br>S.B.72-2514 standard vanes may be welded all over<br>If cracking is suspected at inner weld to platform, chip away the light weight filler sufficiently to ensure weld repairs can be accomplished. Remove the rubber fairing seal locally where necessary |
| (3) Remove paint locally around cracked area | Tool: Scurf mop |
| (4) Cold liquid degrease the areas to be welded | |

B. Weld cracks

| Procedure | Supplementary information |
|---|---|
| (1) Argonarc weld the cracks | See fig.803<br>See 5. Welding data<br>Several weld runs may be necessary if cracks are in the weld joint to centre hub |
| (2) Dress welds to blend with vane profile where possible | |




NOTE :-
PROHIBITED ZONE APPLIES TO PRE MOD 2514 STANDARD OF LP COMPRESSOR OGV's ONLY (DELETION OF CORRUGATED STRIP).
ALL LATER STANDARDS HAVE NO LIMITATIONS.

31 681

DIMENSIONS ARE IN MILLIMETRES WITH INCH CONVERSIONS IN PARENTHESES

Prohibited zone for welding
Fig.803

| Procedure | Supplementary Information |
|---|---|
| (3) WARNING: AS TOXIC FUMES ARE GIVEN OFF DURING THE BURNING OF BLUE FILLER, PERSONS SHOULD NOT BE INSIDE THE FAN CASE DURING HEATING. FUME EXTRACTION IS RECOMMENDED.<br>Heat treat repaired areas at 570 deg.C. (1058 deg.F.) for 30 minutes | Use thermal blankets<br>Slight bulging may occur<br>See 7. Acceptance standards |
| (4) Penetrant crack test | |

C. Prepare repaired vanes (S.B.72-2514) for filling

| Procedure | Supplementary Information |
|---|---|
| (1) Mark out the filler hole | Hole to be mid chord on the concave surface in the centre of vane |
| (2) Drill a 12,7 mm. (0.500in.) diameter (maximum) hole | Fit stop on drill to prevent damaging the inner convex surface |
| (3) Check that hole in outer end of the vane concave side, is not blocked | |
| (4) Check that hole in centre hub is not restricted | Use air line<br>Difficulty in filling vane will be experienced if hole is restricted. In this case drill a 3,175 mm. (0.125in.) diameter hole 12,7 mm. (0.500in.) above lower weld line to allow air to escape. |

D. Prepare the filler material to fill vanes

| Procedure | Supplementary Information |
|---|---|
| (1) Measure out the materials by weight as follows: | |
| 100 parts EC3524 (Blue) Base | OMat, 874 |
| 94 parts EC3524 (White) Accelerator | OMat, 874 |
| 20 parts MY750 | OMat, 803 |
| or | |
| Shell Epon 828 | OMat, 8/8 |
| 2 parts HY951 | OMat, 802 |
| or | |
| Waldorf Enterprises WH951 | |
| (2) Knead the EC3524 constituents until a uniform blue colour without streaks is obtained | |
| (3) Mix HY951 or its alternatives to MY750 or its alternative | |
| (4) Place mixed EC3524 in a container and fold in the liquid mixed in (3) | |
| (5) Mix until complete dispersion is obtained | |

E. Fill prepared vanes (3.C.)

Filling each vane can take up to 30 minutes

| Procedure | Supplementary Information |
|---|---|
| (1) Ensure room temperature is approximately 72 degrees F. (22 degrees C.) | |

| Procedure | Supplementary Information |
|---|---|
| (2) Weigh empty pneumatic applicator and note its weight | |
| (3) Fill the pneumatic applicator with 150 grammes of prepared material | See D and 6. Tools<br>Weigh applicator after filling and establish that it contains the required amount of filler by subtracting weight obtained in (2) |
| (4) Inject filler material until the applicator is completely empty | Extrusion of filler, as the injector pressure is relieved, is to be removed from the vane or root box |
| (5) Cure | 24 hours at 72 degrees F. (22 degrees C.) |

F. Prepare the filler material to renew filler removed in A.(2)

| Procedure | Supplementary Information |
|---|---|
| (1) Measure out the materials by weight as follows:<br>100 parts EC3524 (Blue) Base<br>94 parts EC3524 (White) Accelerator | <br>OMat, 874<br><br>OMat, 874 |
| (2) Knead the materials until a uniform blue colour without streaks is obtained | |

| Procedure | Supplementary Information |
|---|---|
| (3) Spread material on a clean surface to a depth of approximately 12,7 mm. (0.500in.) | This allows exothermic heat dissipation and provides maximum working life of 1 hour at room temperature 72 degrees F (22 degrees C.) |

G. Repair the area of filler removed in A.(2)

| Procedure | Supplementary Information |
|---|---|
| (1) Degrease the areas to be filled | |
| (2) Fill in the gaps between segments and vanes. Any other cavities in the liner annulus line should also be filled | Tool: Clean warm palette knife or trowel |
| (3) Cure | 24 hours at room temperature (72 degrees F., 22 degrees C.) |
| (4) Blend filler if necessary | |

H. Reprotect exposed areas

| Procedure | Supplementary Information |
|---|---|
| (1) Degrease the area | |
| (2) Paint the exposed areas with high heat resisting enamel and allow to air dry | Use PL.82 OMat, 7/22<br>See 70-42-12<br>2 hours at room temperature |

J. Renew or rebond fairing rubber seal

C (1) Material required

C (a) Seal - TWA Stk.Nbr.60-3834.

C (b) Sealant - Scotch-Grip 4500 - TWA Stk.Nbr.50-1190.

CR (c) Sealant - RTV-159 TWA Stk.Nbr.50-1166.

C (2) Procedure

C (a) Remove damaged fairing rubber seal.

C (b) Using scarfed cut, fit new section of seal as
C necessary.

C (c) Cold liquid degrease case and seal with solvent, and
C wipe surfaces with clean rag.

C (d) Apply uniform coat of 4500 to both surfaces. Allow
C 15-30 seconds for adhesive to become tacky. Then
C with hand pressure bring two wet surfaces into
C contact. Bond should be completed within three
C minutes after adhesive has been applied.

CR (e) Allow seal to cure 30 minutes.

CR (f) For instances where material to bond is missing or
CR deteriorated, use RTV-159 to build up area.

CR (g) Check seal installation to case and reinstall core
C cowl ensuring that nose of core cowl fits snugly and
C mates properly with seal.

4. Material of components

| | R.R. Symbol | Material |
|---|---|---|
| L.P. O.G.V. | EAK | 12 per cent Chrome Steel |

5. Welding data

| | |
|---|---|
| Type of welding .. .. | Argonarc D.C. output |
| Torch .. .. .. .. | B.O.C. 200 |
| Electrode .. .. .. | Thoriated tungsten |
| Current .. .. .. .. | 60 Amp. |
| Filler rod .. .. .. | Jethete M.190 R.R. Reference MS 950/10 20 S.W.G. OMat, 3/54 |
| Argon flow .. .. .. | 20 cubic feet/hour |

6. Tools

Thermal blankets

Pneumatic Applicator
(Kent-Moore Model 950-60-11)
or similar, operated on shop air

7. Acceptance standards

Slight bulging may be accepted provided that:-

Bulging does not exceed 6,35 mm. (0.25in.) above surface of vane
Bulging does not occur on more than 3 vanes in any 45 degree arc
Not more than 6 (six) vanes which are bulged to the maximum limits are permitted in any one assembly.
Leading and trailing edges may be distorted up to a maximum of 3,175 mm. (0.125in.)

## 8. Parts

### A. Parts required

| I.P.C. Fig./Item | Part No. | Description |
|---|---|---|
| 03 635 | LK.51360 | Seal |

## 9. Price and Availability

R Engine parts ) Refer to Rolls-Royce plc
Repair of spares )

# L.P. COMPRESSOR FRONT AND REAR CASES

## LOCAL REPAIR OF ACOUSTIC LINING

## FRS.3429

### 1. Effectivity

| I.P.C. Fig./Item | Part No. | | |
|---|---|---|---|
| 01 300 | LK.47616 | Pre S.B.71-2002 | |
| | LK.47655 | S.B.71-2002 | (Part L) |
| | LK.47541 | S.B.72-2032 | |
| | LK.48244 | S.B.71-2322 | (Part H) |
| | LK.43038 | S.B.72-2034 | |
| | LK.56537 | S.B.72-3139 | |
| 04 300 | LK.41297 | Pre S.B.72-2025 | |
| | LK.47636 | S.B.72-2025 | |
| | LK.47538 | S.B.72-2032 | |
| | LK.47625 | S.B.72-2019 | |
| | LK.52795 | S.B.72-2705 | |
| | LK.52382 | S.B.72-2456 | |
| | LK.52759 | S.B.72-2440 | |
| | LK.48249 | S.B.72-2572 | |
| | LK.48191 | S.B.72-2688 | |
| | LK.45422 | S.B.72-2572 | |
| | LK.52415 | S.B.72-2692 | |
| | LK.52870 | S.B.72-2692 | Part 2 |
| | LK.52871 | S.B.72-2692 | Part 3 |
| | LK.52872 | S.B.72-2692 | Part 4 |
| | LK.52488 | S.B.72-3177 | Part 1 |
| | LK.52491 | S.B.72-3177 | Part 2 |
| | LK.66513 | S.B.72-4012 | Part 1 |
| | LK.68580 | S.B.72-4012 | Part 2 |

### 2. Deleted

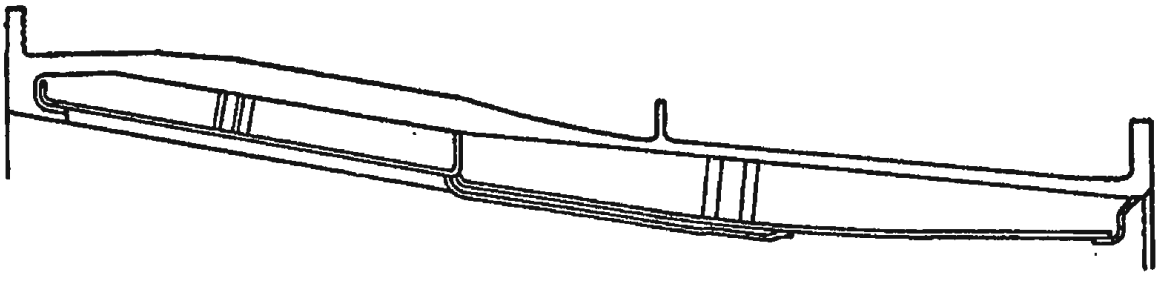
## 3. Instructions

### A. Prepare the areas of damage

| Procedure | Supplementary Information |
|---|---|
| (1) Dress the area to remove loose debris or drill a hole or holes for injection of filler into the damaged area | See fig.804<br>Tool: Hand tools |
| (2) Lightly planish if necessary | See fig.804 Section AD<br>Ensure edges of damaged area are underflush |
| (3) Thoroughly degrease the area | Drench in inhibited trichloroethane 1.1.1 OMat, 174 |
| (4) Immediately dry out area with air blast | Use oil free air |

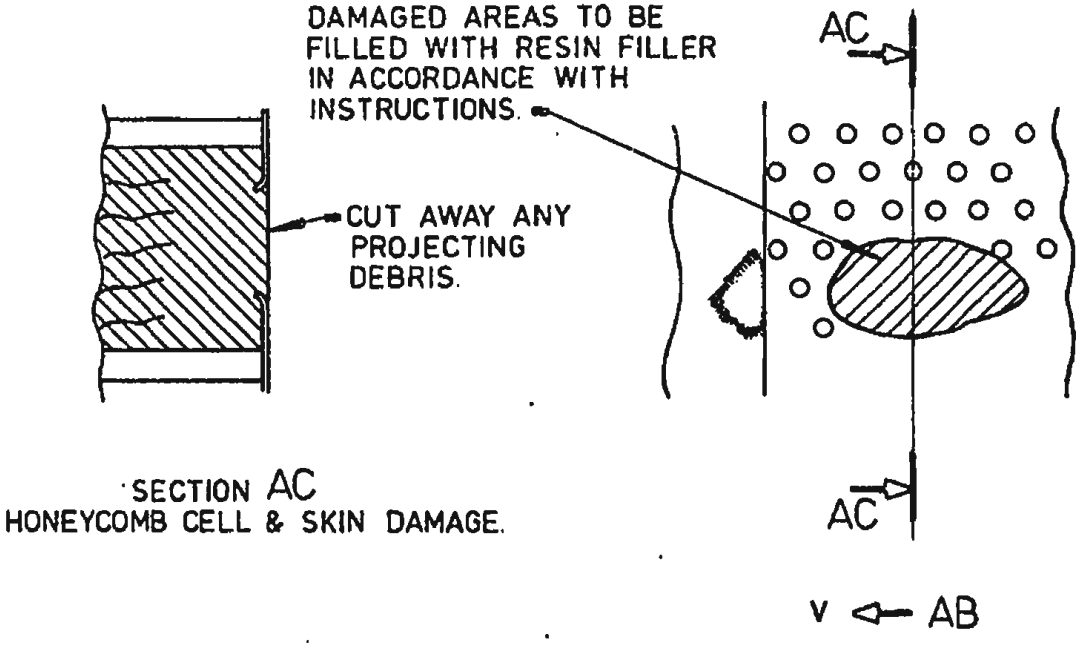
### B. Prepare the filling material EC3524 B and A

| Procedure | Supplementary Information |
|---|---|
| (1) Measure out the materials by weight as follows: | |
| 100 parts EC3524 (Blue) base | OMat, 874 |
| 94 parts EC3524 (White) accelerator | OMat, 874 |
| | See 6. Parts |
| (2) Mix the materials by kneading until a uniform blue colour without streaks is obtained | |



TYPICAL SECTION THROUGH
L.P. COMPRESSOR FRONT CASE.

AB




SECTION AC
HONEYCOMB CELL & SKIN DAMAGE.

A2558

CR
CR

Acoustic lining and typical repair
Fig.804

| Procedure | Supplementary Information |
|---|---|
| (3) Spread material on a clean surface to a depth of approximately 0.500in. | This allows exothermic heat dissipation and provides maximum working life of 1 hour at room temperature (72 degrees F., 22 degrees C.) |

C. Apply the filling material

| Procedure | Supplementary Information |
|---|---|
| (1) Slightly overfill the damaged area | Tool: Hand tools or pneumatic injection gun |
| (2) Partially cure | Allow sufficient time for filling material to start to stiffen |
| (3) Remove excess material | Tool: Clean, warm palette knife or trowel<br>Remove majority of excess material by a planing or burnishing action<br><br>NOTE: Clean blade before reheating |
| (4) Cure | 24 hours at room temperature (72 degrees F., 22 degrees C.)<br>Lower temperature will prolong the cure time<br>Higher temperature will accelerate the cure (200 degrees F., 93 degrees C. to 1/2 hour approximately) |
| (5) Blend the filling material to contour | Tool: Hand tools and glass-paper<br>Carry out immediately material is hard to the touch |

| Procedure | Supplementary Information |
|---|---|
| (6) Paint repaired area | Use PL.82 OMat, 7/22 T.S.D.594, O.P.312 |
| (7) Visually inspect | |
| (8) Vibro-engrave 'FRS.3429' adjacent to part number | |

4. Material of component

| | R.R. Symbol | Material |
|---|---|---|
| Compressor case | EAF | Chromium Nickel (18/8) Stainless Steel |
| Attrition lining | | Nomex honeycomb |
| Acoustic lining | | Aluminium honeycomb<br>Aluminium perforate skin |
| Attrition lining backing | | Glass reinforced composite |
| Edge frames | | Glass reinforced composite |
| Adhesive | | Epoxy resin |

5. Tools

Special tools are not required

6. Parts

Micro balloon filled Epoxy resin

Supplied by
Minnesota Mining and Manufacturing Co.,
St. Paul,
Minnesota,
U.S.A.

7. Price and Availability

R Repair of spares - Refer to Rolls-Royce plc

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# L.P. COMPRESSOR OUTLET GUIDE VANES - RESTORE AERODYNAMIC SHAPE OF VANE WHEN A PIECE HAS BROKEN OUT (7 VANES MAXIMUM) TEMPORARY REPAIR

## FRS.3695

## 1. Effectivity

| I.P.C. Fig./Item | Part No. | |
|---|---|---|
| | LK.47650 | Pre S.B.72-2514 |
| | LK.51299 | S.B.72-2514 |

## 2. Instructions

### A. General

This scheme is to cover the restoration of the aerodynamic shape when a piece of skin has broken out. The repair is of a temporary nature and the affected vane should be replaced in accordance with FRS.3580 (Repair Manual) at the earliest opportunity, but the limits given in the maintenance manual for one vane missing should not be exceeded.

The repair is limited to 7 vanes per assembly of which 2 may be adjacent vanes.

It should be noted that this scheme in no way restores any strength to the vane. Its purpose is to reduce the turbulence caused by the missing material, and cracking repaired in accordance with this scheme is not additional to that already permitted by the Maintenance Manual.

### B. Repair the vane

| Procedure | Supplementary Information |
|---|---|
| (1) Degrease the area using an evaporating solvent | Use acetone or methyl ethyl ketone OMat, 135 |

| Procedure | Supplementary Information |
|---|---|
| (2) Prepare blue filler | Refer to T.S.D.594, O.P.707 for EC3524 B/A blue filler preparation procedures OMat 874 |
| (3) Immediately fill the hole and the surrounding cavity with the filler | |
| (4) Smooth the filler material to the contours of the vane | |
| (5) Apply a strip of 'Mylar' aluminium self-adhesive tape or similar over the repair area | The material should wrap round the leading edge so that both edges of the material are downstream |

3. Materials

Materials called out in this scheme may be obtained from the Minnesota Mining and Manufacturing Company Limited or their authorised distributors.

The materials are:

EC3524 A/B Filler

EC3911 Degreasing Primer

'Mylar' Aluminium Self-adhesive tape

4. Parts

No special parts are required

5. Repair of Spares

Not applicable

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# L.P. COMPRESSOR FRONT CASING

## LOCAL REPAIR OF ATTRITION LINING

## FRS.3428

### 1. Effectivity

| I.P.C. Fig./Item | Part No. | | |
|---|---|---|---|
| 01 300 | LK.47616 | Pre S.B.71-2002 | |
| | LK.47655 | S.B.71-2002 | (Part L) |
| | LK.47541 | S.B.72-2032 | |
| | LK.48244 | S.B.71-2322 | (Part H) |
| | LK.43038 | S.B.72-2034 | |
| | LK.56537 | S.B.72-3139 | |
| | LK.62536 | S.B.72-4223 | |

### 2. Deleted

### 3. Instructions

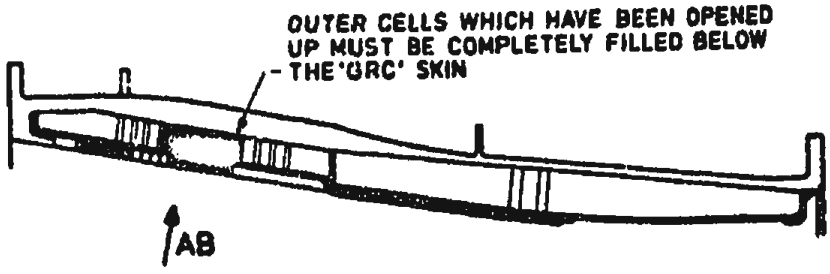
A. Prepare the areas of damage

| Procedure | Supplementary Information |
|---|---|
| (1) Remove the defective area by picking and dressing | See fig.805<br>Tool: Hand tools<br>Take care not to damage the Glass Reinforced Composite (G.R.C.) skin which is sandwiched between the two layers of honeycomb in this area. |

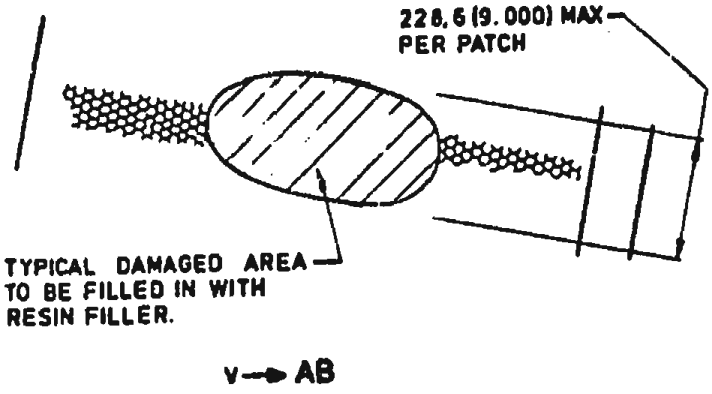
| Procedure | Supplementary Information |
|---|---|
| (2) Inspect the G.R.C. skin and check for indications of blistering or lack of bond by pressing or tapping | If blistering or lack of bond is apparent carry out all the following operations. If the G.R.C. is sound omit operations (3) and C.(1) |
| (3) Cut away the defective area | Tool: Hand tools |
| (4) Thoroughly degrease the repair area | Drench the area in 1.1.1. Trichloroethane OMat, 174 and brush vigorously with a paint brush |
| (5) Immediately dry out area using an air blast | Use oil free air |
| (6) Check for residual oil or hydraulic fluid by smelling | If characteristic odour of oil or hydraulic fluid is present repeat operations (4) to (6) |
| (7) Degrease the area | Use Acetone OMat, 1/13 or Methyl Ethyl Ketone (M.E.K.) OMat, 135 and allow the solvent to evaporate |

B. Prepare the filling material EC 3524 B/A

| Procedure | Supplementary Information |
|---|---|
| (1) Measure out the materials by weight as follows<br><br>100 parts of EC 3524 (Blue) base<br>94 parts of EC 3524 (White) accelerator | OMat, 874<br>See 6. Parts |




TYPICAL SECTION THROUGH
LP COMPRESSOR FRONT CASE.




DIMENSIONS ARE IN MILLIMETRES WITH
INCH CONVERSIONS IN PARENTHESES.

EXTENT OF REPAIR NOT TO EXCEED 50% OF THE
TOTAL HONEYCOMB SEAL AREA.

48343A

R Attrition lining and typical repair
R Fig.805

| Procedure | Supplementary Information |
|---|---|
| (2) Mix the material by kneading until a uniform blue colour without streaks is obtained | |
| (3) Spread out the material on a clean surface to a depth of approximately 0.500in. | This allows maximum exothermic heat disipation and provides a working life of the mixture of approximately 1 hour at room temperature 72 degrees F. (22 degrees C). |

C. Apply the filling material

| Procedure | Supplementary Information |
|---|---|
| (1) Fill the cavity between the casing and the G.R.C. skin | |
| (2) Fill the remaining cavity | Tool: Use knife, spatula or trowel<br>Slightly overfill the area |
| (3) Partially cure | Allow sufficient time for filling material to start to stiffen |
| NOTE : During the curing cycle it is recommended that localised clamping is employed to support the filler at points where it could sag. | |
| (4) Remove excess material | Tool: Clean, warm palette knife or trowel<br>Remove the majority of the excess material by a cutting or burnishing action |
| | NOTE: Clean blade before reheating |

| Procedure | Supplementary Information |
|---|---|
| (5) Cure | 24 hours at room temperature (72 degrees F., 22 degrees C.) Lower temperature will prolong the cure time<br><br>Higher temperature will accelerate the cure (200 degrees F., 93 degrees C. to 1/2 hour approximately) |
| (6) Blend the filling material to contour | Tool: Hand tools and garnet paper<br><br>Carry out immediately the filling material is hard to the touch and does not ball or clog the garnet paper |
| (7) Visually inspect | |
| (8) Vibro-engrave 'FRS.3428' adjacent to the part number | |

4. Material of components

| | R.R. Symbol | Material |
|---|---|---|
| Casing | EAF | Chromium Nickel (18/8) Stainless Steel |
| Attrition lining | | Nomex honeycomb |
| Acoustic lining | | Aluminium honeycomb Aluminium perforate skin |
| Attrition lining backing | | Glass reinforced composite |
| Edge frames | | Glass reinforced composite |
| Adhesive | | Epoxy resin |

5. Tools

Special tools are not required

6. Parts

EC 3524 B/A

Supplied by
Minnesota Mining and Manufacturing Co.
St. Paul
Minnesota
U.S.A.

7. Price and availability

R Repair of spares Refer to Rolls-Royce plc

## L.P. COMPRESSOR FRONT CASE -

## REPAIR THE ICE IMPACT AREA SURFACE COATING

## FRS.3579

This repair covers the application of the erosion coating on:

A. A casing with the L.P. compressor (Fan) module in situ.

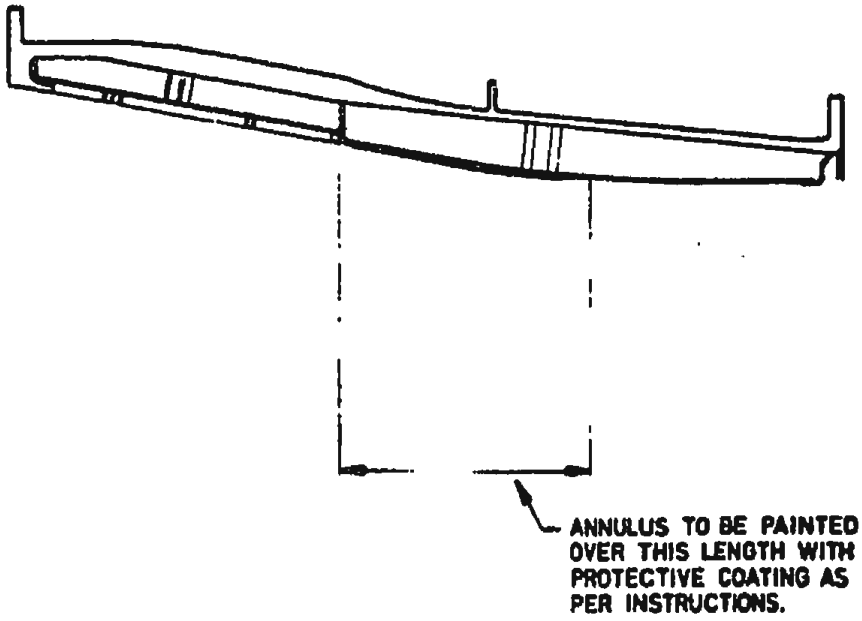
B. A casing either removed from an engine or assembled to an engine but with the L.P. compressor (Fan) module removed.

| I.P.C. Fig./Item | Part No. | |
|---|---|---|
| 01 300 | LK47616 | |
| | LK47655 | S.B.71-2002 item L |
| | LK47541 | S.B.72-2032 |
| | LK48244 | S.B.71-2322 item H |
| | LK43038 | S.B.72-2034 |
| | LK56537 | S.B.72-3139 |
| | LK62536 | S.B.72-4223 |

2. Instructions

A. Prepare defective area

| | Procedure | Supplementary Information |
|---|---|---|
| (1) | Cut away the loose polyurethane coating | For area see fig.806 |
| (2) | Swab the area locally to remove grease | Use MEK OMat, 135 or Acetone OMat, 150 |
| (3) | Thoroughly abrade the repair area | |




BASIC SECTION THROUGH FRONT L.P. COMPRESSOR CASE.

GEOMETRIC SYMBOLS CONFORM TO I.S.O R1101-1969
MACHINE WHERE MARKED ☑
DIMENSIONS ARE IN MILLIMETRES WITH INCH CONVERSIONS IN PARENTHESES

37914

R Repair area
R Fig.806

| Procedure | Supplementary Information |
|---|---|
| (4) Swab the prepared area | Use MEK or Acetone |

B. Mix the coating materials - assembled engine - Method A

| Procedure | Supplementary Information |
|---|---|
| The mixes given below are alternatives and either may be used. | |
| (1) Mix by weight | |
| Araldite S.V.409 | 70 parts OMat, 805 |
| Versamid Polyamide 140 | 30 parts OMat, 806 |
| (2) Mix by weight | |
| Shell Epon 828 | 100 parts OMat, 8/8 |
| Shell Epon curing agent T | 20 parts OMat, 8/9 |
| | Mix the components by stirring for approximately 1 to 2 minutes and ensure that a homogenous mix is obtained |

C. Apply the coating - assembled engine - Method A

| Procedure | Supplementary Information |
|---|---|
| (1) Paint the prepared area to produce a coating of approximately 0,254 mm. (0.010in.) thickness | |

| Procedure | Supplementary Information |
|---|---|
| (2) Cure for 24 hours at room temperature 22 deg.C. (72 deg.F.) | Increased temperature will accelerate the cure |

D. Mix the coating materials - disassembled engine - Method B

| Procedure | Supplementary Information |
|---|---|
| (1) Measure out the materials by weight as follows:<br>100 grams of Adiprene LW.520<br>13.5 grams of hardener HY.932 | OMat 8/50<br>OMat 8/51 |
| (2) Warm the Adiprene LW.520 to 100 deg.C. (212 deg.F.) | This is to thin the material to assist mixing |
| (3) Mix the hardener HY.932 into the Adiprene LW.520 | To ensure the correct quantity of hardener is added rinse the container with a small quantity of Methylethyl-ketone (M.E.K.)<br>OMat 135 |

E. Apply the coating - disassembled engine - Method B

| Procedure | Supplementary Information |
|---|---|
| (1) Immediately after mixing apply a thick coat by brush | |
| (2) Gell using a hot air gun | |

| Procedure | Supplementary Information |
|---|---|
| (3) Repeat application and gelling if necessary | |
| (4) Cure for 4 hours at (125 ± 5 deg.C. (257 ± 9 deg.F.) or 24 hours at room temperature (22 deg.C. (72 deg.F). | |

3. Material of Components

| Description | R.R. Symbol | Description |
|---|---|---|
| Casing | EAF | Stainless Steel Chromium Nickel (18/8) |
| Acoustic lining | LCR | Aluminium Perforate Aluminium Honeycomb |
| Fillers and Adhesives | | Epoxy Resins |

4. Tools

Special tools are not required.

5. Parts

Not applicable.

6. Prices and Availability

Not applicable.

# L.P. COMPRESSOR FRONT CASE - REPAIR ATTRITION LINING FRS.4686

## 1. Effectivity

| I.P.C. Fig./Item | Part No. | |
|---|---|---|
| 01 300 | LK47616 | |
| | LK47655 | S.B.71-2002M |
| | LK47541 | S.B.72-2032 |
| | LK48244 | S.B.71-2322H |
| | LK43038 | S.B.72-2034 |
| | LK56537 | S.B.72-3139 |
| | LK62536 | S.B.72-4223 |

## 2. Equipment and Material

A. Standard equipment

Item 1 Standard workshop tools

B. Consumable materials

| | | |
|---|---|---|
| Item 1 | OMat 874 | Filler |
| Item 2 | OMat 174 | Inhibited 1.1.1. trichloroethane |
| Item 3 | OMat 150 | Acetone |
| Item 4 | OMat 135 | Methylethylketone (M.E.K.) |
| Item 5 | OMaf 5/97 | Garnet paper |

C. Special tools

Item 1 Boring fixture - MW1865
Item 2 Adapter kit - MW1873
Item 3 Control unit - EIG19991

D. Expendable parts - None required

E. Repair parts - None required

## 3. General

A. Repair can be applied to assemblies where damage to fan track attrition lining does not extend beyond glass reinforced plastic (GRP) skin.

B. Any area can be repaired.

C. No back filling of Nomex honeycomb behind internomex GRP skin is permitted.

D. Damage which penetrates internomex GRP skin can be repaired to FRS.3428 providing affected area does not exceed 50 per cent of honeycomb area.

E. Material of component

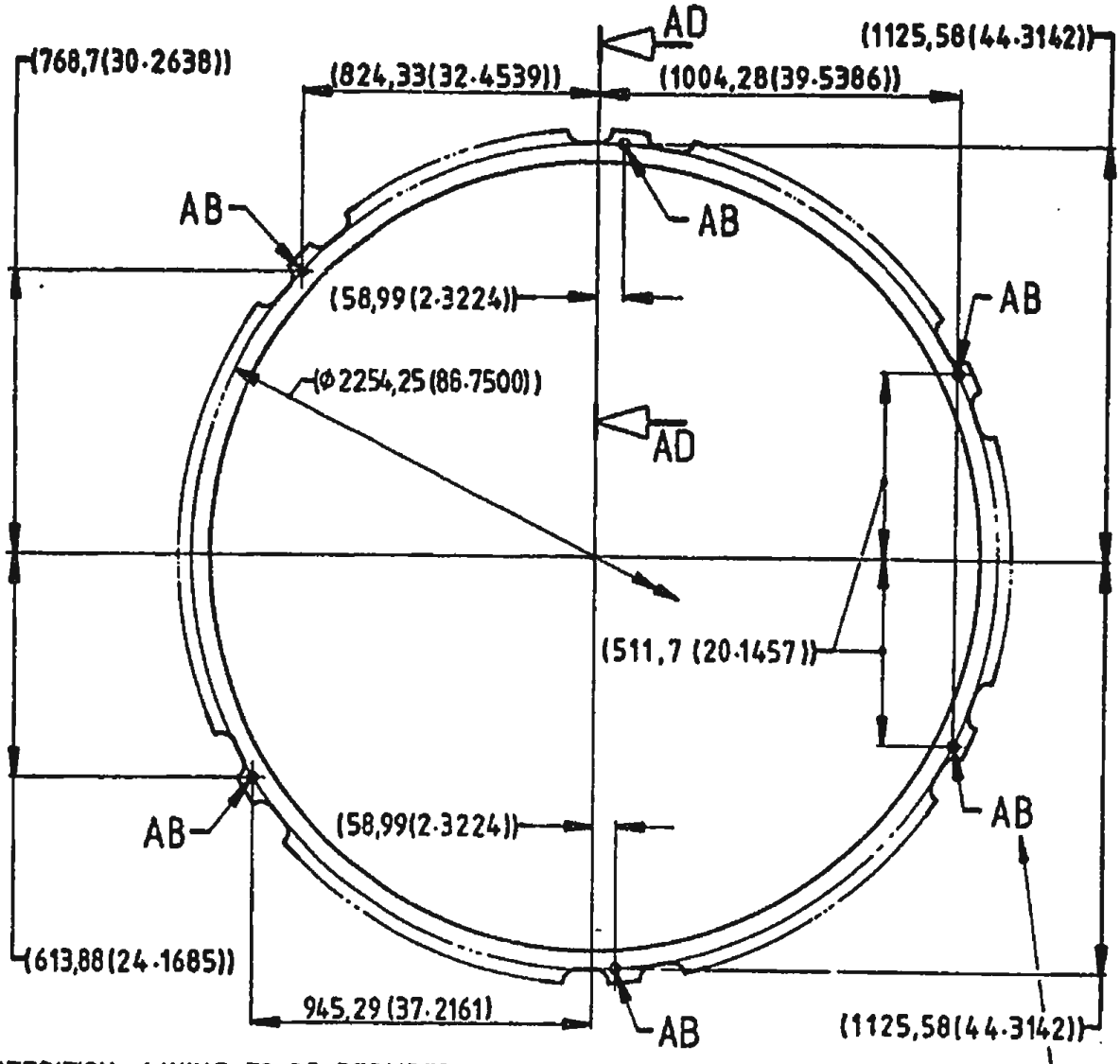
| Description | R.R. Symbol | Material |
|---|---|---|
| Case | EAL | Chromium nickel (18/8) Stainless steel |
| Attrition lining | | Nomex honeycomb |
| Attrition lining membrane | | Glass reinforced plastic (GRP) |

F. Price and availability

R Tools - Refer to Rolls-Royce plc

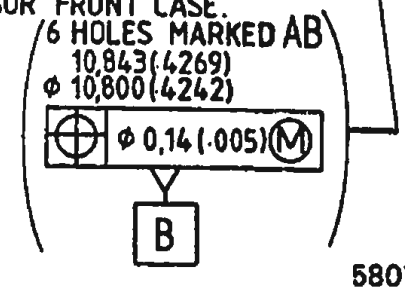
Engine parts - Not applicable

Repair of spares - Not applicable




ATTRITION LINING TO BE REPAIRED WITH SPEC A FILLER.
AREA WITHIN WHICH REPAIR MAY BE CARRIED OUT IS SHOWN MARKED AC AND MAY EXTEND TO THE FULL 360° BUT MUST NOT GO BEYOND THE DEPTH OF THE NOMEX HONEYCOMB.
DIMENSIONS ARE IN MILLIMETRES(INCHES).
GEOMETRIC SYMBOLS CONFORM TO ISO R1101-1969.

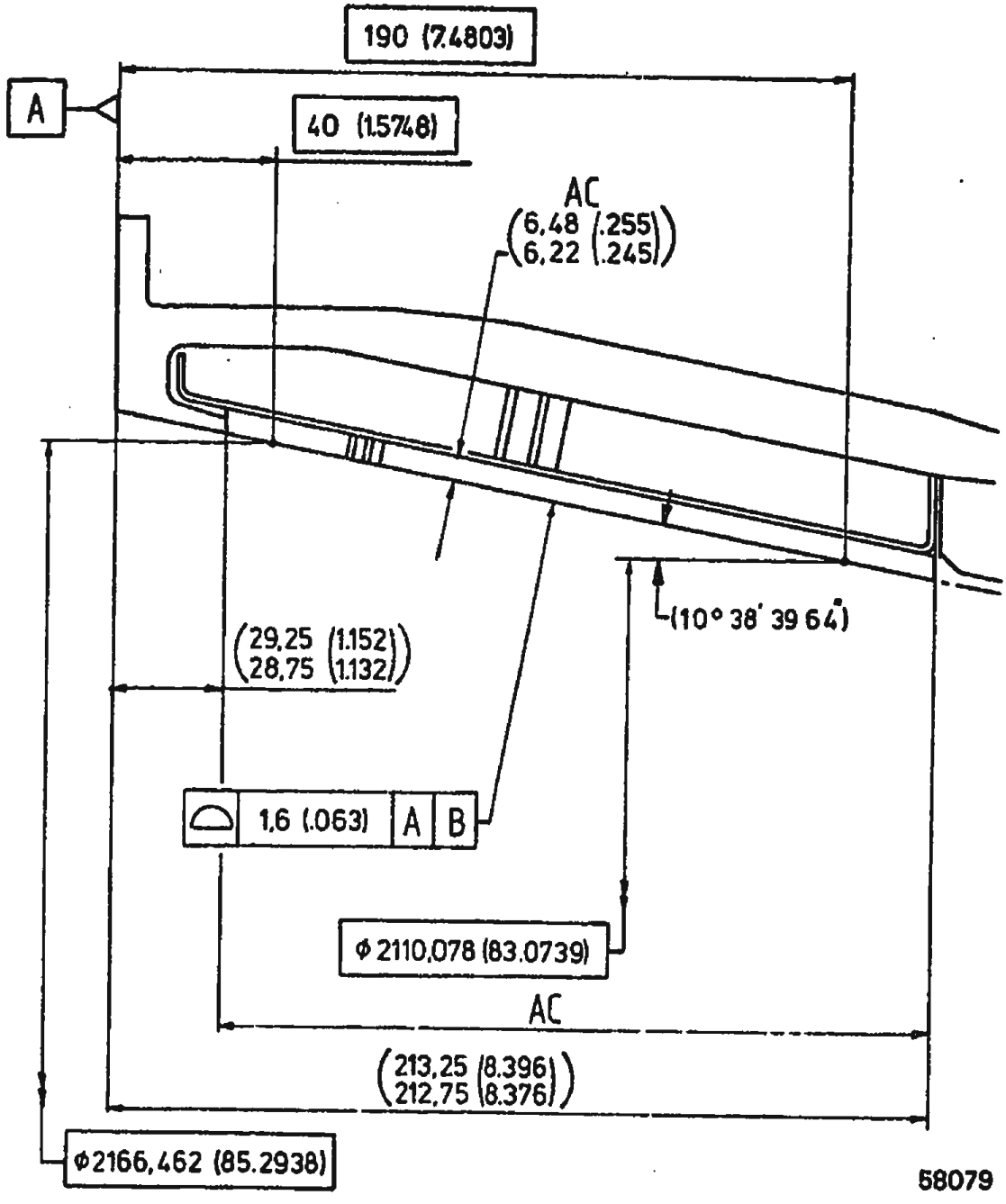
VIEW ON FRONT FLANGE OF L.P. COMPRESSOR FRONT CASE.




58077

Repair details
Fig.807

EFFECTIVITY: ALL




SECTION AD

R Repair details
R Fig.808

4. Instructions

A. Prepare damaged area

| | Procedure | Supplementary Information |
|---|---|---|
| (1) | Clear debris from damaged area including any loose attrition lining | Check for loose attrition lining by pressing or tapping. Do not exceed dimensions AC.<br><br>Fig.807 and 808<br><br>Ensure internomex glass reinforced plastic (GRP) skin is not damaged |
| (2) | Inspect GRP skin and check for indications of blistering or lack of bond by pressing or tapping | If damage extends through internomex GRP skin, repair to FRS.3428 |
| (3) | Thoroughly degrease damaged area | T.S.D.594, O.P.101 Consumable material Item 2 and brush vigorously with a paint brush |
| (4) | Immediately dry out | Use dry oil-free air |
| (5) | Hand abrade G.R.P. skin | Consumable material Item 5 |

| Procedure | Supplementary Information |
|---|---|
| (6) Remove grit and dust | Use vacuum cleaner, Standard equipment Item 1 |
| (7) Degrease repair area | Consumable material Item 3 or 4. Allow to evaporate |

B. Prepare filler

| Procedure | Supplementary Information |
|---|---|
| (1) Prepare and mix filler | Consumable materials Item 1 T.S.D.594, O.P.707 |

C. Apply filler material

| Procedure | Supplementary Information |
|---|---|
| (1) Fill damaged area and cure filler material | T.S.D.594, O.P.707 |

D. Final machine rotor path

| Procedure | Supplementary Information |
|---|---|
| WARNING: OPERATOR MUST TAKE ADEQUATE PRECAUTIONS TO AVOID INHALATION OF MACHINING DUST | |
| (1) Assemble boring attachment to case and machine rotor path to dimensions shown; remove on completion | Refer to fig.807, 808. Use Special tools Item 1, 2 and 3. Do not use lubricant |

| Procedure | Supplementary Information |
|---|---|
| Machining data | |
| Machine speed - 5 r.p.m.<br>Feed - 0,254 to 6,35 mm. (0.010 to 0.250in.) per rev.<br>Cut - 6,35 mm. (0.250in.) maximum | |
| (2) Remove residual machining deposits | Use vacuum cleaner, Standard tool Item 1 |
| (3) Inspect machined surface visually and dimensionally | Refer to fig.807 and 808 |
| (4) Vibro-engrave FRS.4686 adjacent to part number | |

# L.P. COMPRESSOR FRONT CASE - REPAIR DENTS IN ICE IMPACT PANEL USING BLUE FILLER FRS5141

This repair covers — Repair dents in L.P. compressor front case ice impact panel using blue filler

## 1. Effectivity

| I.P.C. Fig./Item | Part No. | |
|---|---|---|
| 01 300 | LK47616 | |
| | LK47655 | S.B.72-2002 |
| | LK47541 | S.B.72-2032 |
| | LK48244 | S.B.72-2322 |
| | LK43038 | S.B.72-2034 |
| | LK56537 | S.B.72-3139 |
| | LK62536 | S.B.72-4223 |

## 2. Equipment and Materials

A. Standard equipment

Use hand tools
500g capacity scales accurate to 1g
Vibro-engraving equipment

B. Consumable materials

OMat 283 Transparent tape
Polythene sheet
OMat 874 Filler
OMat 5/97 Garnet paper

C. Special tools - none required

D. Expendable parts - none required

E. Repair parts - none required

R 3. General

R A. This Repair details the method of repairing dents in the L.P. compressor front case impact panel using blue filler.

R B. The repair is limited to a total accumulative area of damage to any panel of 30 per cent.

R C. Material of components

| DESCRIPTION | RR SYMBOL | MATERIAL |
|---|---|---|
| L.P. compressor case | TAW | Titanium alloy |
| Ice impact panel | LHE | Aluminium honeycomb |
| | VBQ | Glass fabric 0,08 mm. (0.003in.) thick |
| | VBP | Glass fabric 0,25 mm. (0.010in.) thick |

R D. Price and availability - not applicable

R 4. Remove Damaged Material, Inspect Damage and Prepare Repair Area

R A. Remove damaged material

| Procedure | Supplementary Information |
|---|---|
| (1) Blank off I.P. compressor intake | Use OMat 283 transparent tape and polythene sheet |
| (2) Remove loose and damaged material from the repair area | Use hand tools |

R B. Inspect size of damage

| Procedure | Supplementary Information |
|---|---|
| (1) Visually inspect repair area | The repair is limited to a total accumulative area of damage to any panel of 30 per cent |

R C. Prepare repair area

| Procedure | Supplementary Information |
|---|---|
| (1) Prepare repair area | T.S.D.594, O.P.707 |

R 5. Apply Filler Material, Inspect and Identify the Repair

R A. Prepare and apply the filler material

| Procedure | Supplementary Information |
|---|---|
| (1) Prepare the filler material | T.S.D.594, O.P.707. Use OMat 874 filler and 500g capacity scales accurate to 1g |
| (2) Apply the filler material to the prepared area | T.S.D.594, O.P.707 |

R B. Re-create aerodynamic smoothing

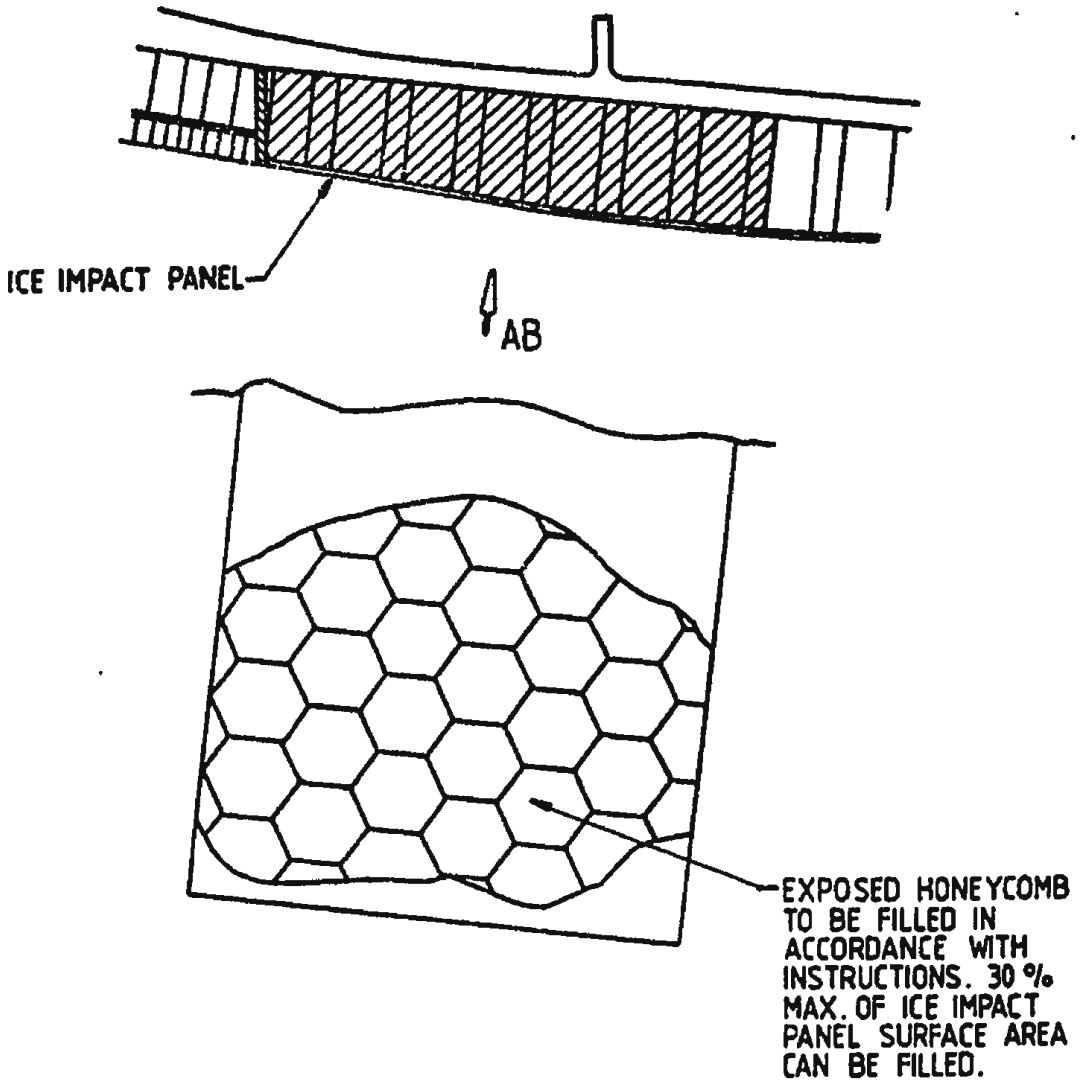
| Procedure | Supplementary Information |
|---|---|
| (1) Re-create aerodynamic smoothing | Use OMat 5/97 garnet paper |

R C. Visually inspect the repair

| Procedure | Supplementary Information |
|---|---|
| (1) Visually inspect the repair area | Ensure that no steps have been created |
| (2) Remove intake blanking | |

R D. Identify the repair

| Procedure | Supplementary Information |
|---|---|
| (1) Vibro-engrave FRS5141 adjacent to existing part number | Use vibro-engraving equipment |


ICE IMPACT PANEL
AB
EXPOSED HONEYCOMB TO BE FILLED IN ACCORDANCE WITH INSTRUCTIONS. 30 % MAX. OF ICE IMPACT PANEL SURFACE AREA CAN BE FILLED.
VIEW AB

82622

R R Section through repair area
Fig.809

R L.P. COMPRESSOR FRONT CASE, MISSING ACOUSTIC PANELS

R RESTORATION OF AERODYNAMIC SMOOTHNESS

R FRS1127

R 1. Effectivity - ALL

R 2. Instructions

R A. Prepare areas of damage

| R PROCEDURE | SUPPLEMENTARY INFORMATION |
|---|---|
| R (1) Dress out damaged material around the edges of the depression left by the missing panel | TOOL: Hand tools<br>Any loose material should be removed prior to the application of filler |
| R (2) Degrease area to be filled | Moisten a clean, dry, lint free cloth with OMat 1/21 1.1.1. trichloroethane and swab the area. Discard the soiled cloth after use |

R B. Prepare filling material EC3524 B/A

| R PROCEDURE | SUPPLEMENTARY INFORMATION |
|---|---|
| R (1) Measure out materials by weight as follows:<br>100 parts of EC3524 (Blue) base<br>94 parts of EC3524 (White) accelerator | OMat, 874<br>See 4. Parts |
| R (2) Mix material by kneading until a uniform blue colour, without streaks, is obtained | |

| | PROCEDURE | SUPPLEMENTARY INFORMATION |
|---|---|---|
| R (3) | Spread out material on a clean surface to a depth of approximately 0.500in. (12,7 mm.) | This allows maximum exothermic heat dissipation and provides a working life for the mixture of approximately 1 hour at room temperature 72 deg.F. (22 deg.C.) |

R C. Apply filling material

| | PROCEDURE | SUPPLEMENTARY INFORMATION |
|---|---|---|
| R (1) | Apply filler to form a fillet around the edges of the adjacent panels | TOOL: Use knife, spatula or trowel<br>Refer to Fig.810 |
| R (2) | Partially cure | See T.S.D.594, O.P.707<br>Refer to blue filler cure data chart.<br>Allow sufficient time for the filling material to start to stiffen |
| R (3) | Remove excess material | TOOL: Clean, warm palette knife or trowel.<br>Remove majority of excess material by cutting or burnishing action.<br><br>NOTE: Clean blade before re-heating. |
| R (4) | Blend filling material to contour | TOOL: Hand tools and garnet paper.<br>Effect immediately filling material is hard to the touch and does not ball or clog garnet paper |
| R (5) | Visually inspect | |
| R (6) | Vibro-engrave FRS1127 adjacent to part number | |

R 3. Tools

R Special tools are not required

R 4. Parts

R EC3524 B/A
R Supplied by:
R Minnesota Mining and Manufacturing Co.,
R St.Paul
R Minnesota
R U.S.A.

R 5. Consumable Materials

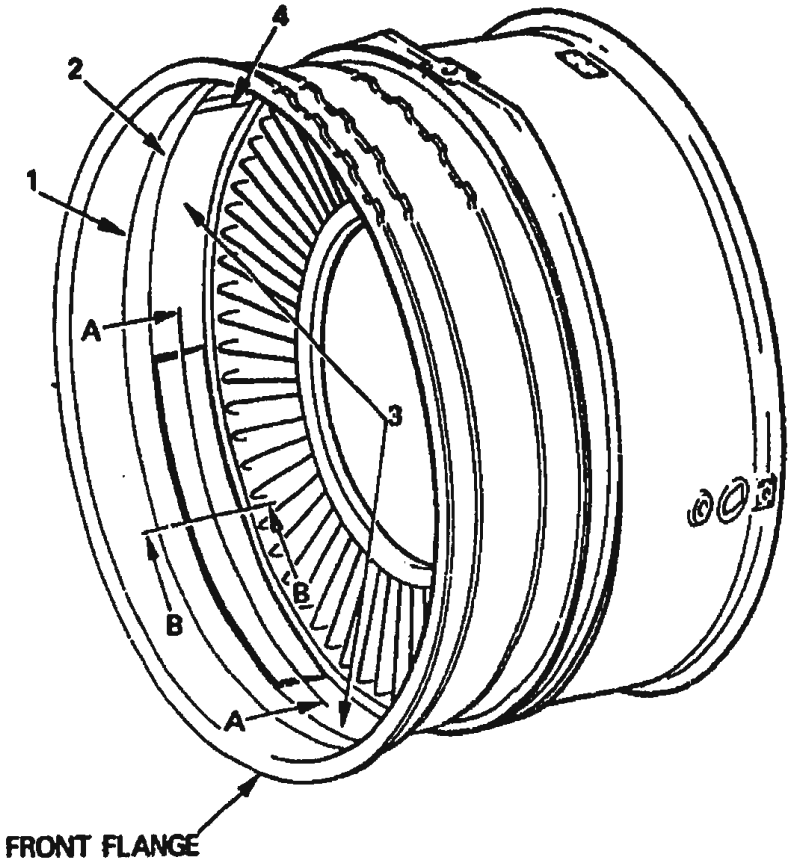
R OMat 874 Filler Two-pack
R OMat 1/21 Inhibited and stabilized 1.1.1. trichloroethane

R To identify consumable materials refer to the Overhaul Materials
R Manual, OMat.

R For other consumable materials required to accomplish this repair
R refer to T.S.D.594 O.P.707)

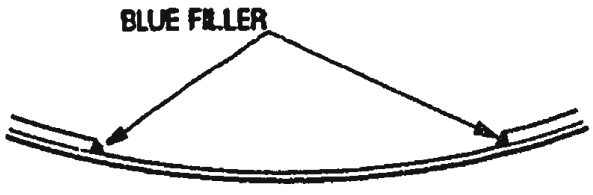
R 6. Price and Availability

R Repair of spares - Refer to Rolls-Royce plc

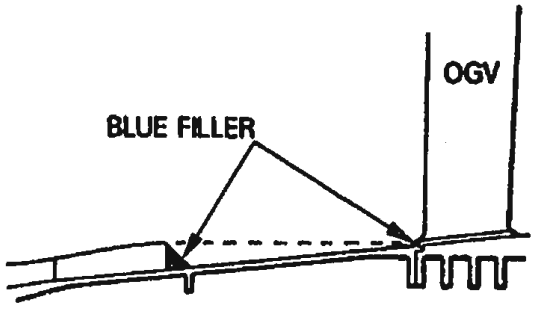



FORWARD

1 Attrition lining
2 Ice impact panel
3 Acoustic panel
4 Edge sealing strip




SECTION AA




SECTION BB

A8442

R Repair details
R Fig.810

R EFFECTIVITY: ALL

# LOW PRESSURE (L.P.) COMPRESSOR DISC AND BLADES - REMOVAL/INSTALLATION

## MINI-MODULE 01/1

## INSTALLED WING MOUNTED POWER PLANT

Referenced Procedures:

| | |
|---|---|
| 72-31-03 | Spinner and anti-icing tube - removal/installation |
| 72-31-05 | L.P. compressor rotor blades - inspection/check |
| 72-31-01 | L.P. compressor case and vanes - inspection/check |

### 1. General

For standard torque loadings and torque tightening technique, refer to 70-51-00.

Special torque loadings and assembly tolerances are detailed at appropriate stage of the procedure.

Discard all rubber seal rings and key washers removed during removal sequence.

For identification, lubrication and fitting of rubber seal rings, refer to 70-02-01.

For information on fitting of Vee-band coupling clamps, refer to 70-12-02.

On completion of assembly, joint flanges, securing features and any area where surface protection is damaged or deteriorated must be re-protected by applying air drying enamel of the appropriate colour. The air drying enamels required are listed in 70-42-12.

Positional relationship is based on engine in flight position. Detailed radial locations are numbered in a clockwise direction starting from engine top position and viewed from rear unless otherwise specified.

R Two methods of removing/installing the L.P. compressor disc and
R blades are detailed:

R - Method 1 uses a slinging frame and turnover stand

R - Method 2 uses a L.P. fan turnover sling.

## 2. Equipment required

| | Part No. | Description |
|---|---|---|
| | CP20091/1 | Sling |
| | CP30343/4 | Stand, parking nose cowl (Use with CP30450/1 or CP30508) |
| | HU20747/1 | Extractor, anti-icing tube support cone |
| | HU20055 or HU26565 (S.B.72-4917) | Support (Pre S.B.72-4917) |
| | HU19564/1 (SWE10673) | Adapter, socket |
| | HU19565/3 (SWE10473) | Immobiliser |
| | HU21395/1 | Tool, retaining |
| | HU21402 | Nose |
| | 1704300 or | Gearbox, reduction, Sweeney |
| R | 1012394 | |
| | HU12763 (SWE10473) | Plate, anchor |
| | HU21403 | Plate, information |
| | HU21410 | Bar, pilot |
| | HU21675/2 | Cradle, installation |
| | HU26966 | Handle |
| | HU21396 | Handle |
| | XUT42395 | Sleeve, protection |
| | XUT38280 | Lifter |
| | CP21853/1 | Shaft, slave |
| | CP30086/3 | Stand, parking and turnover |
| | WARNING: CP30086, CP30086/1 AND CP30086/2 MUST NOT BE USED. | |
| | XUT38260/C or HU27780 | Tool, shaft pilot |
| | HU20593/1 | Pilot, shaft |
| | HU20133/3 | Tool, lifting |
| | HU21490 | Ring |
| | CP30042 | Frame, slinging |
| | CP30072/2 | Sling, beam, multi-purpose |
| | CP30646 | Sling, alternative to CP30042 and CP30072/2 |
| R | CP30745/1 | L.P. fan turnover sling |

| | |
|---|---|
| HU20704/3 | Spanner, disassembly only |
| XUT41736 | Spanner, run-down only |
| HU21468 | Plate, index |
| HU21398/1 | Spanner, torque tightening only |
| HU21397 | Tool, assembly |
| HU20073 | Punch |
| HU20072/2 | Tool, swaging |
| HU29175 | Bolt, dummy (Qty 3-off) |
| HU29179 | Wrench, adjusting |
| CP30450/1 or CP30508 | Location ring (Use with CP30343/4) |

3. Prepare to remove L.P. compressor disc and blades

WARNING: ENSURE THAT ENGINE BEING WORKED ON IS ISOLATED FROM STARTER AIR AND ELECTRICAL POWER SUPPLY.

A. Open left-hand and right-hand hinged cowls, 71-11-00.

B. Remove nose cowl, fig.401

CAUTION: THE NOSE COWL ASSEMBLY WEIGHS APPROXIMATELY 540 LB. (245 KG.).

(1) Disconnect electrical connectors, P1 air connector.

(2) Disconnect fire bottle discharge harness, pip pins and anti-icing duct coupling clamp.

(3) Attach sling, CP.20091/1, to hoist and to slinging points on nose cowl.

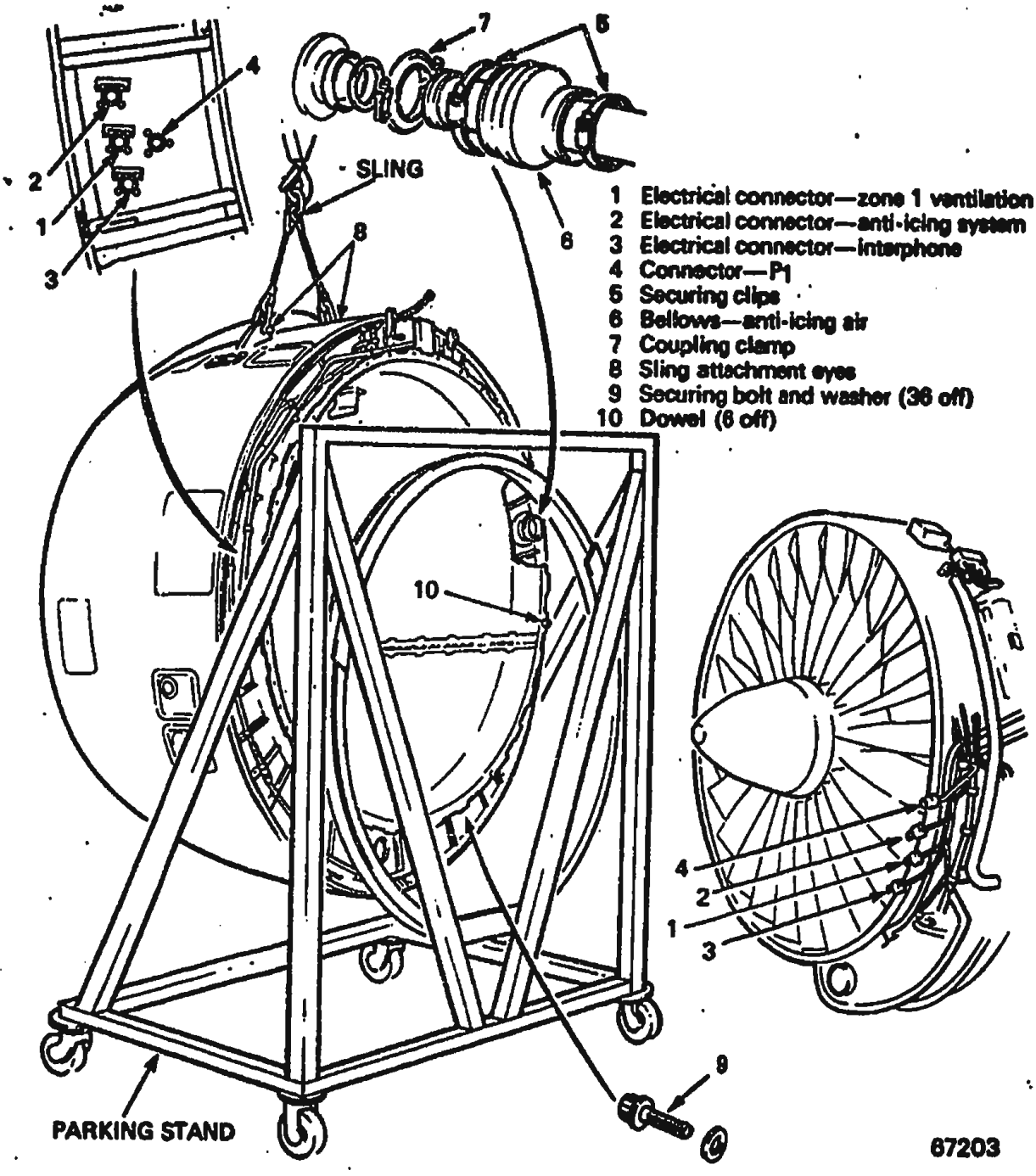
(4) Take weight on hoist and remove securing bolts and washers.

(5) Move nose cowl forward to clear locating dowels and to clear L.P. compressor rotor spinner.

(6) Lower nose cowl into parking stand, CP.30343/4, secure to stand and remove sling.

(7) Close left-hand and right-hand hinged cowls, 71-11-00.

C. Remove L.P. compressor spinner and anti-icing tube (Ref. 72-31-03).




Remove/Install nose cowl
Fig.401

4. Remove L.P. compressor disc and blades

A. Remove L.P. compressor fail-safe shaft.

(1) Fit tubular bolt retaining tool, HU.21395/1, fig.402.

(a) Remove clamp nut from outer tube of retaining tool.

(b) Unscrew expander nut and collapse expanding legs.

(c) Insert retaining tool through bore of fail-safe shaft and locate pot assembly in bore of tubular bolt.

(d) Continue pushing tool rearward until red alignment mark on outer tube is rearward of forward face of fail-safe shaft.

(e) Hold outer tube and pull handle forward to open expanding legs.

(f) Run down expander nut but do not tighten at this stage.

(g) Grip outer tube and pull tool forward until expanding legs contact rear face of tubular bolt; the red alignment mark on the outer tube should be in line with forward face of fail-safe shaft when tool is positioned correctly.

(h) Fully tighten expander nut.

(2) Remove L.P. compressor shaft retaining nut, fig.402.

(a) Fit support, HU.20055 or HU.26565, to front flange of fail-safe shaft.

(b) Fit socket adapter, HU.19564/1, through bore of fail-safe shaft to locate in spannering slots in outside diameter of retaining nut.

(c) Screw nose, HU.21402, into rear end of immobiliser, HU.19565/3.

(d) Enter immobiliser through bore of socket adapter to locate in bore of tubular bolt and engage dogs at forward end of bolt.

(e) Fit reduction gearbox, 1704300 or 1012394, to socket adapter.

(f) Fit anchor plate, HU.12763, to reduction gearbox.

(g) Fit information plate, HU.21403, to outer tube of retaining tool.

CAUTION: L.P. SHAFT RETAINING BOLT NUT IS LEFT-HAND THREAD.

(h) Fit and tighten clamp nut on outer tube of retaining tool.

(j) Release L.P. shaft retaining bolt nut and turn nut clear of bolt.

(k) Remove clamp nut, information plate, anchor plate and reduction gearbox.

(l) Remove immobiliser, socket adapter and support.

(m) Remove nut, cupwasher and thrust ring from centre bolt.

R NOTE: The cupwasher must be discarded.

CAUTION: DO NOT RELEASE OR ATTEMPT TO REMOVE TUBULAR BOLT RETAINING TOOL.

(3) Remove L.P. compressor fail-safe shaft Fig.404.

(a) Fit pilot bar, HU.21410, through bore of L.P. compressor fail-safe shaft and engage on threads of tubular bolt, fig.403, using handle, HU.21396.

NOTE: The tubular bolt has a left-hand thread.

(b) Fit installation cradle, HU.21675/2, secure with clamps to rotor disc and secure sliding support and handle, HU26966 to flange of fail-safe shaft, fig.404.

(c) Pull handle to withdraw fail-safe shaft forward along installation cradle.

(d) Enter immobiliser through bore of socket adapter to locate in bore of tubular bolt and engage dogs at forward end of bolt.

R R (e) Fit reduction gearbox, 1704300 or 1012394, to socket adapter.

(f) Fit anchor plate, HU.12763, to reduction gearbox.

(g) Fit information plate, HU.21403, to outer tube of retaining tool.

CAUTION: L.P. SHAFT RETAINING BOLT NUT IS LEFT-HAND THREAD.

(h) Fit and tighten clamp nut on outer tube of retaining tool.

(j) Release L.P. shaft retaining bolt nut and turn nut clear of bolt.

(k) Remove clamp nut, information plate, anchor plate and reduction gearbox.

(l) Remove immobiliser, socket adapter and support.

(m) Remove nut, cupwasher and thrust ring from centre bolt.

CAUTION: DO NOT RELEASE OR ATTEMPT TO REMOVE TUBULAR BOLT RETAINING TOOL.

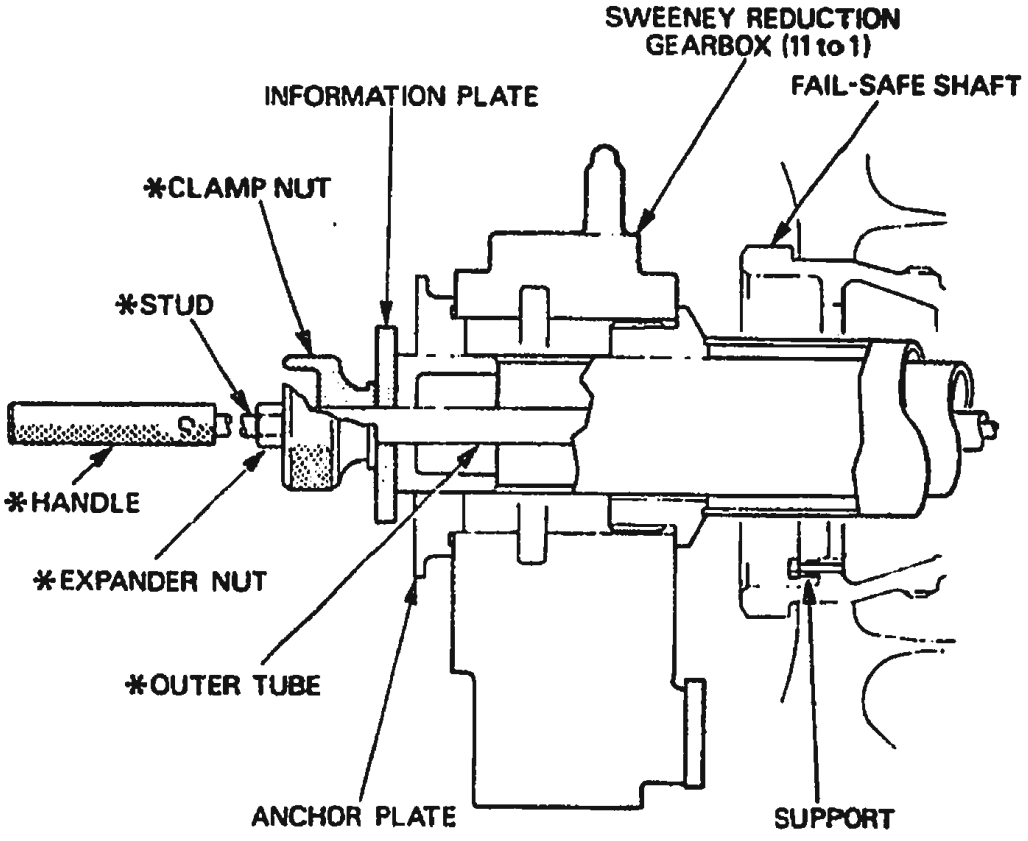
(3) Remove L.P. compressor fail-safe shaft Fig.404.

(a) Fit pilot bar, HU.21410, through bore of L.P. compressor fail-safe shaft and engage on threads of tubular bolt, fig.403, using handle, HU.21396.

NOTE: The tubular bolt has a left-hand thread.

(b) Fit installation cradle, HU.21675/2, secure with clamps to rotor disc and secure sliding support and handle, HU26966 to flange of fail-safe shaft, fig.404.

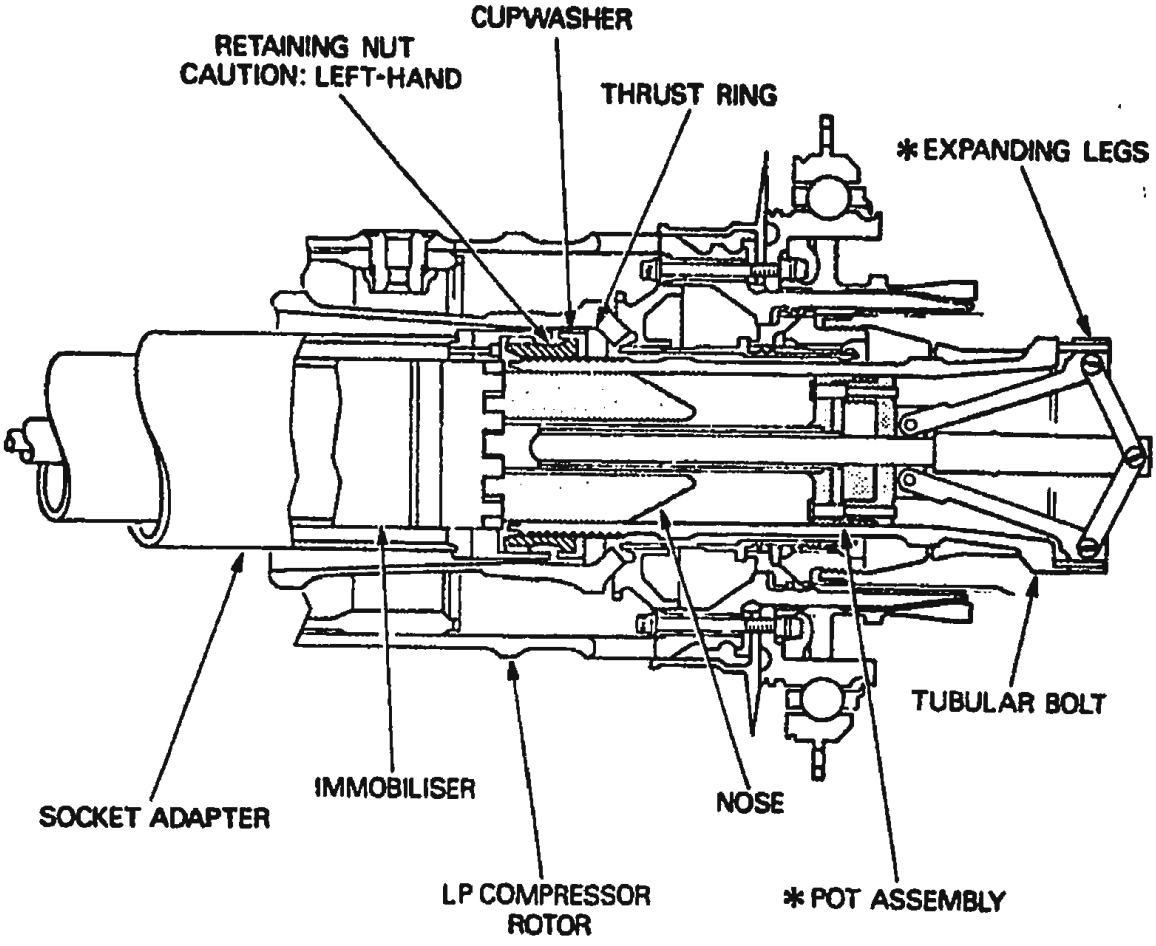
(c) Pull handle to withdraw fail-safe shaft forward along installation cradle.




*Detail of retaining tool

34246A

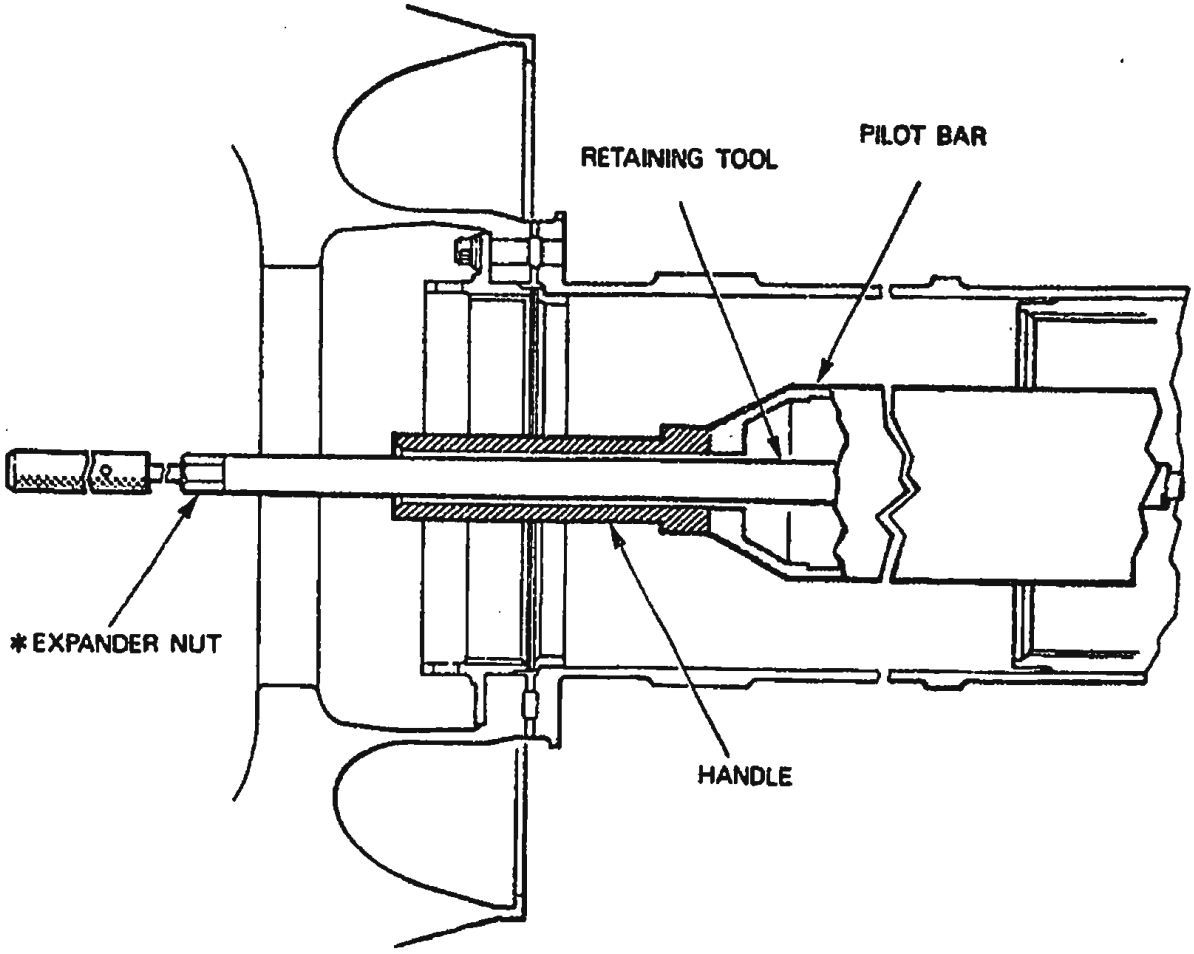
Remove/Install L.P. shaft retaining bolt nut
Fig.402, Sheet 1




* Details of retaining tool

34247A

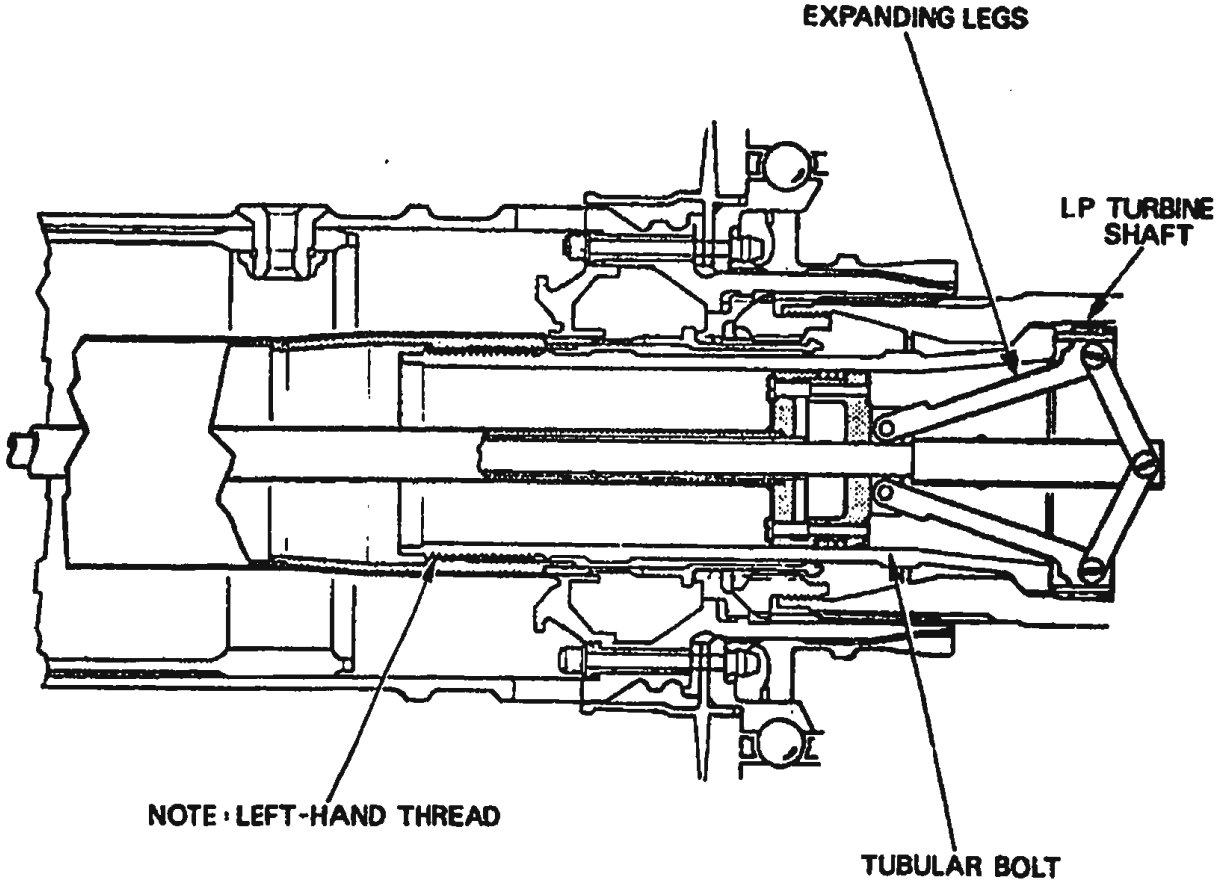
Remove/Install L.P. shaft retaining bolt nut
Fig.402, Sheet 2



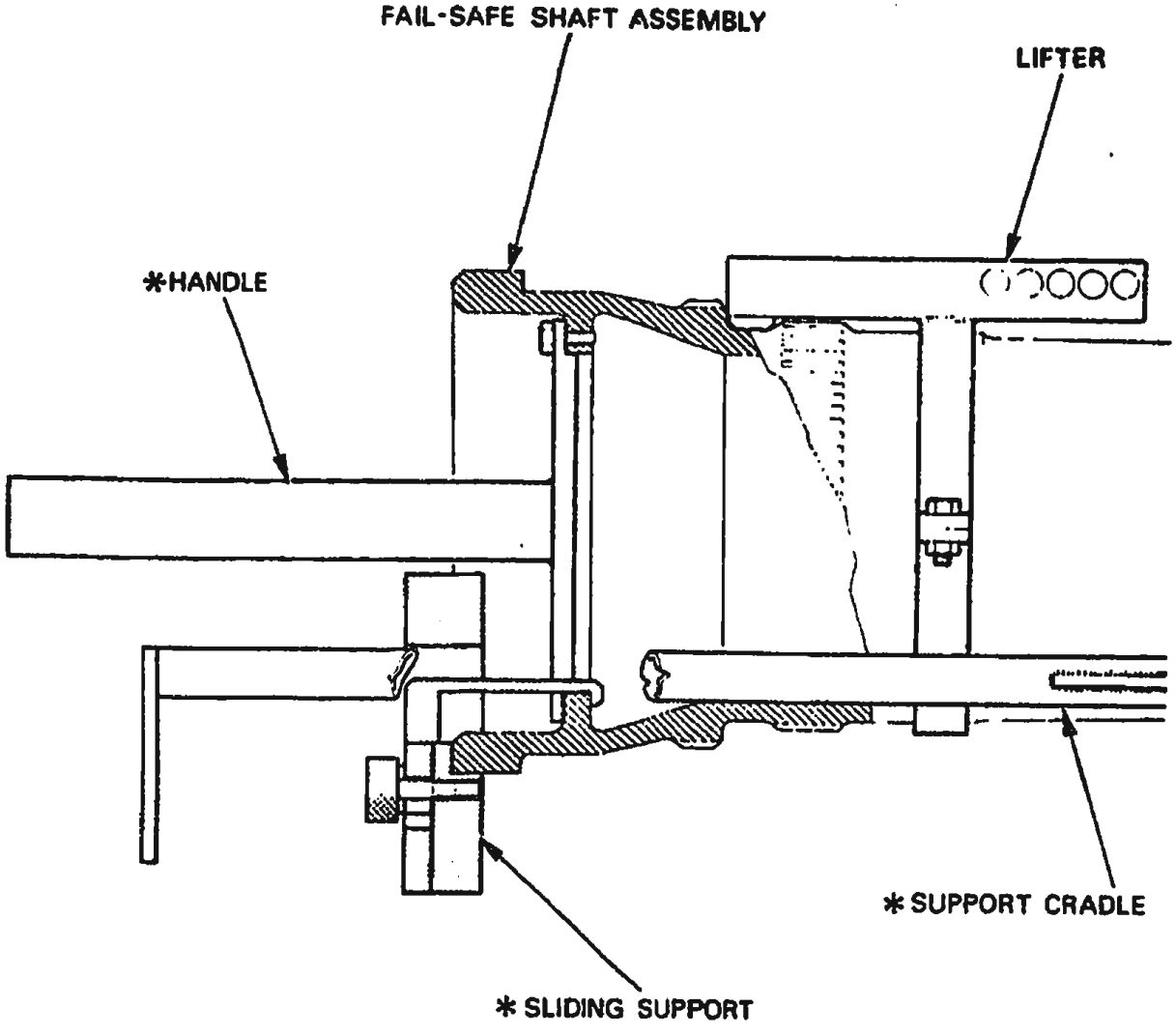

*Details of retaining tool

34248A

Fit pilot bar to assembled tubular bolt
Fig.403, Sheet 1



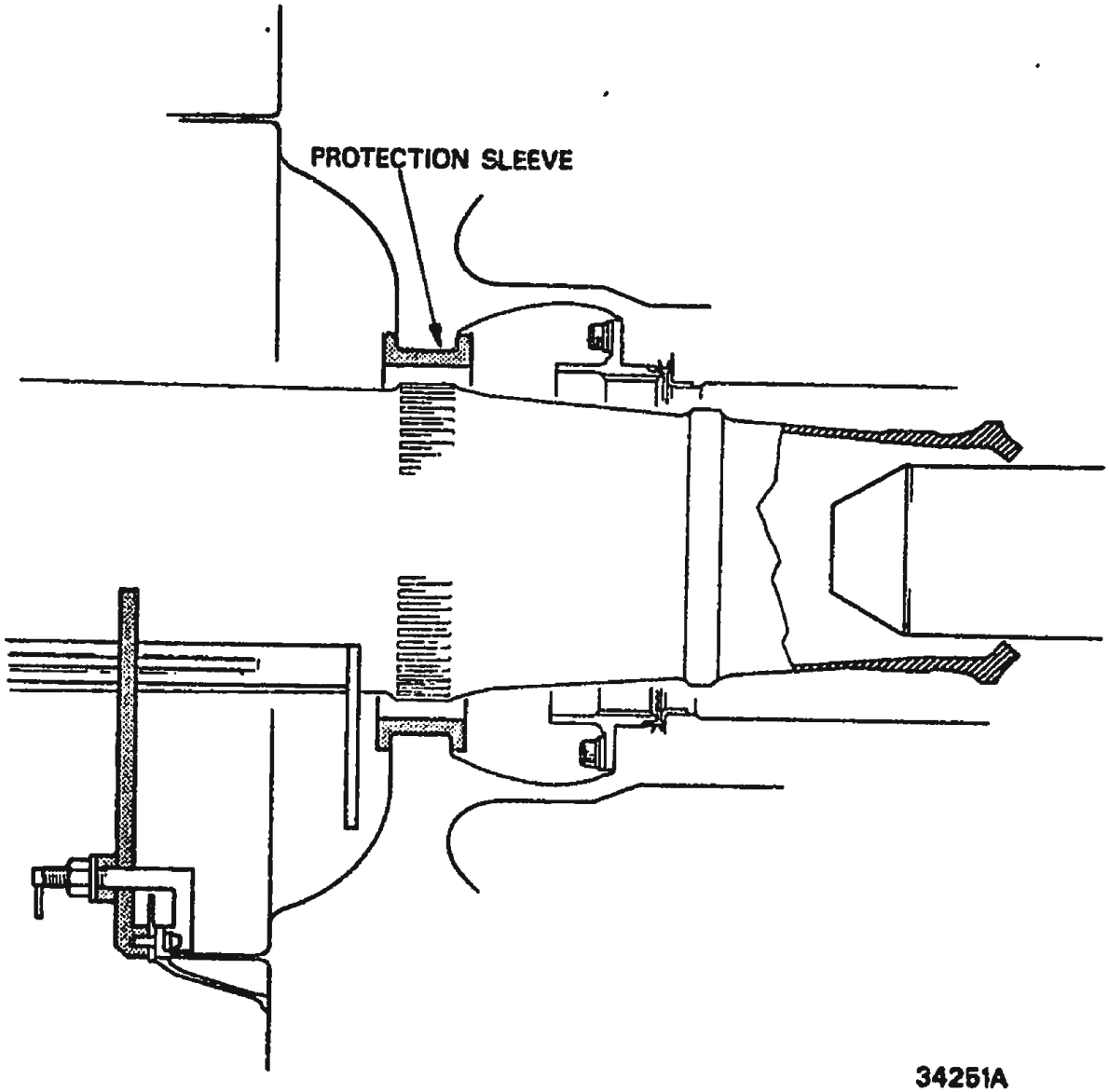

Fit pilot bar to assembled tubular bolt
Fig.403, Sheet 2




* DETAILS OF INSTALLATION CRADLE

34250A

Remove/Install fail-safe shaft
Fig.404, Sheet 1




Remove/Install fail-safe shaft
Fig.404, Sheet 2

(d) Fit protection sleeve, XUT.42395, to bore of L.P. compressor rotor disc, fig.404.

(e) Fit and secure lifter, Ref.416, to fail-safe shaft.

(f) Attach hoist to lifter and take weight of fail-safe shaft.

(g) Release sliding support from flange of fail-safe shaft and lift shaft clear of cradle.

(h) Lower fail-safe shaft and remove lifter and handle.

(i) Remove installation cradle.

(j) Remove pilot bar from tubular bolt using handle, HU.21396, fig.403.

NOTE: The tubular bolt has a left-hand thread.

R B. Method 1. Fit slave shaft to parking and turnover stand,
R fig.405.

(1) Position turnover stand, CP.30086/3 and slave shaft, CP.21853/1 in working area.

(2) Hoist shaft to position in stand: fit and tighten clamps to secure.

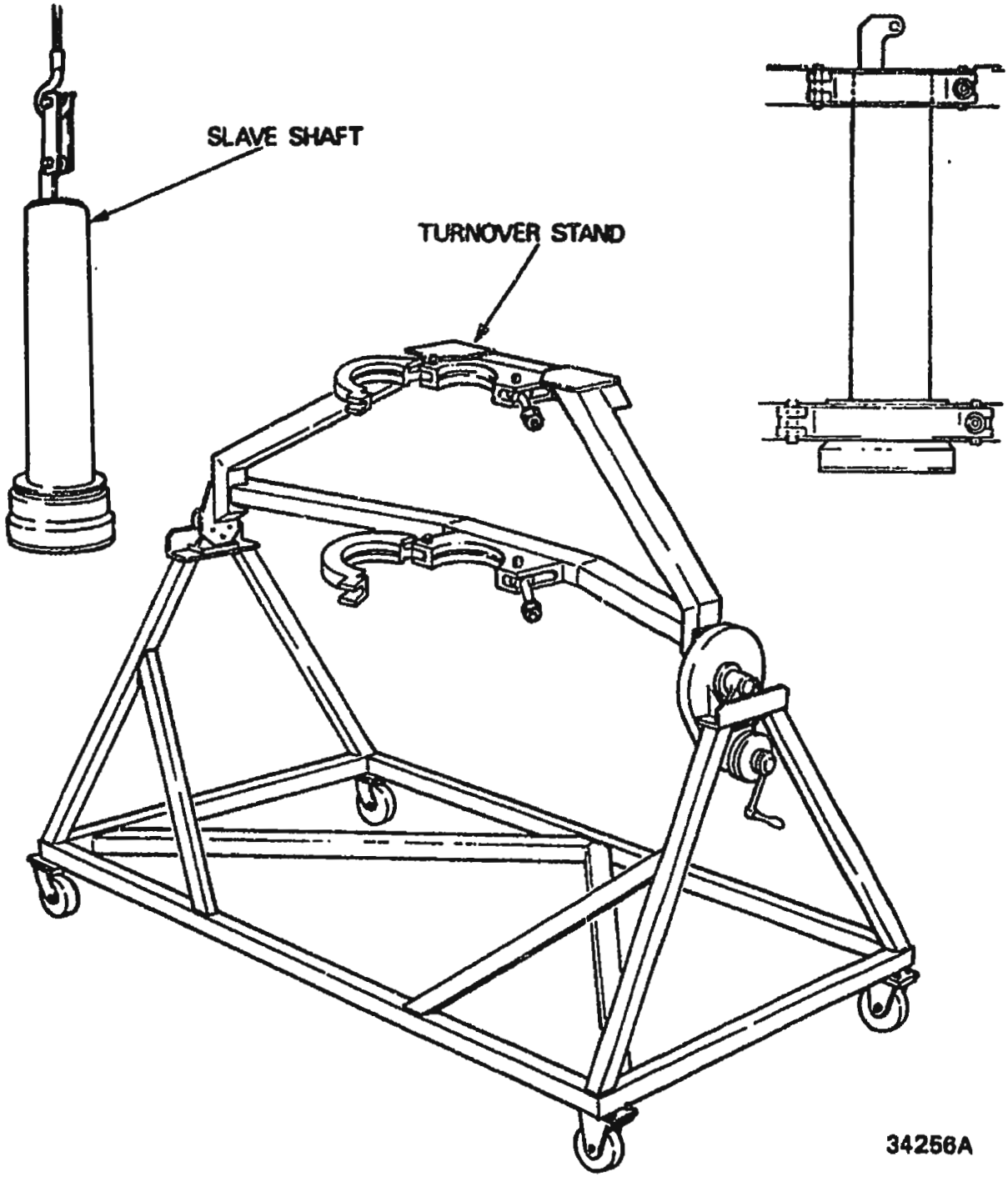
R C. Method 1. Assemble and fit slinging and support tools,
R fig.406 (Sheet 1).

(1) Insert shaft pilot tool, XUT.38260/C, or HU27780 into bore of compressor and locate against tubular bolt.

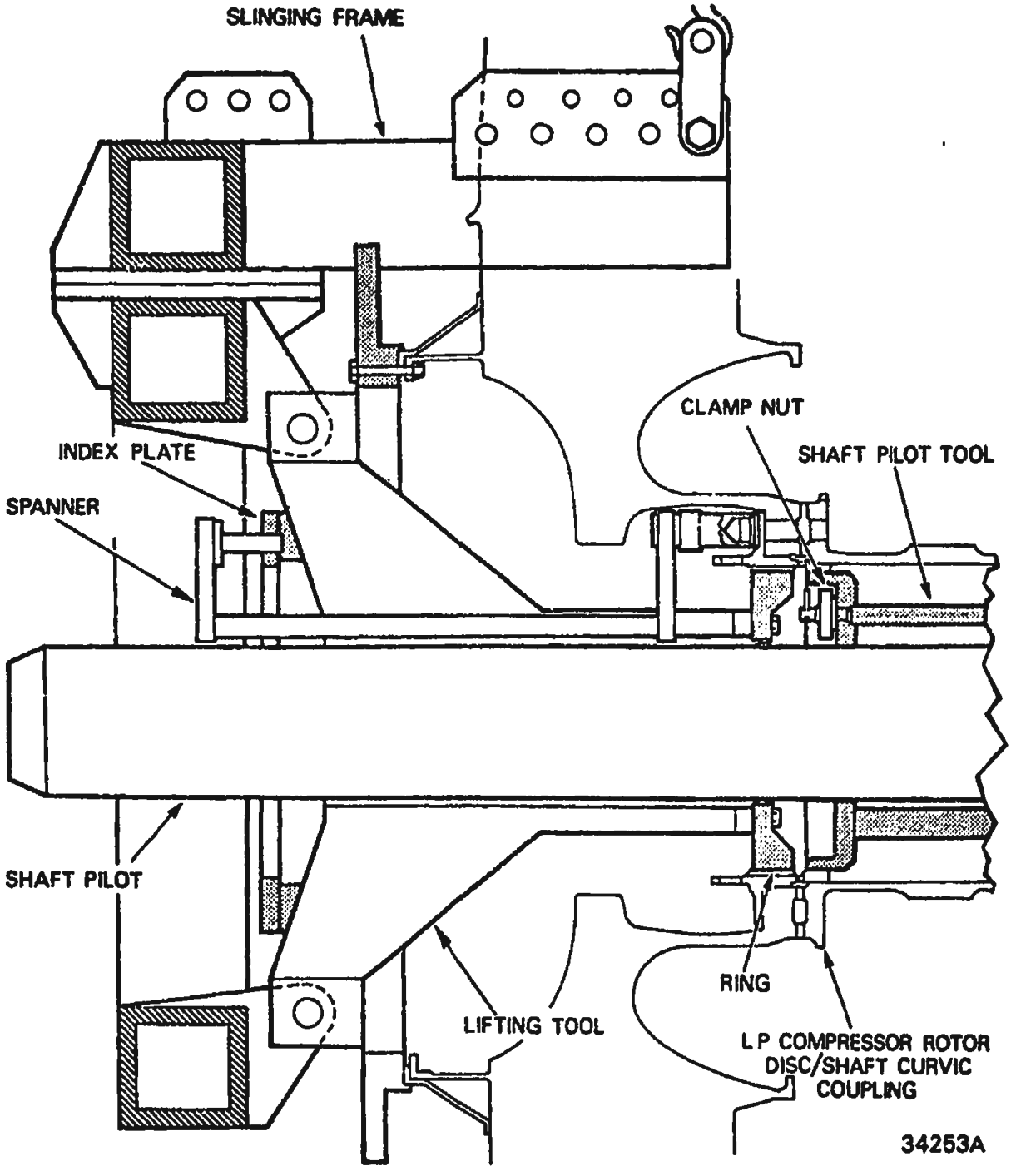
(2) Slacken expander nut of retaining tool, HU.21395/1, fig.403, an amount sufficient to allow the tubular bolt to be moved rearward.

(3) Push shaft pilot tool into position locating in L.P. turbine coupling locking sleeve holding retaining tool handle to keep tubular bolt in abutment with shaft pilot tool.

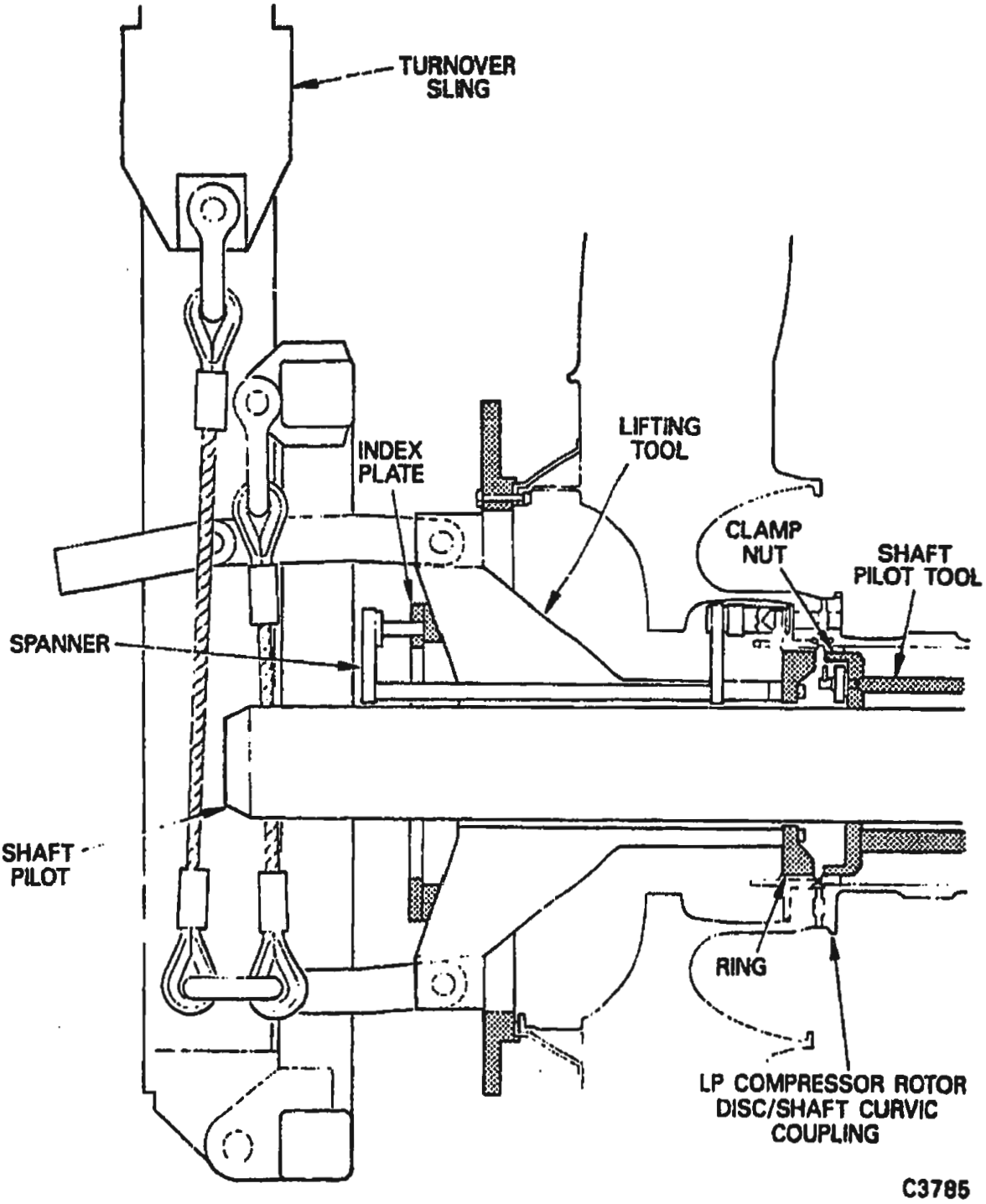
(4) Tighten expander nut of retaining tool to clamp tool and bolt in L.P. turbine shaft.



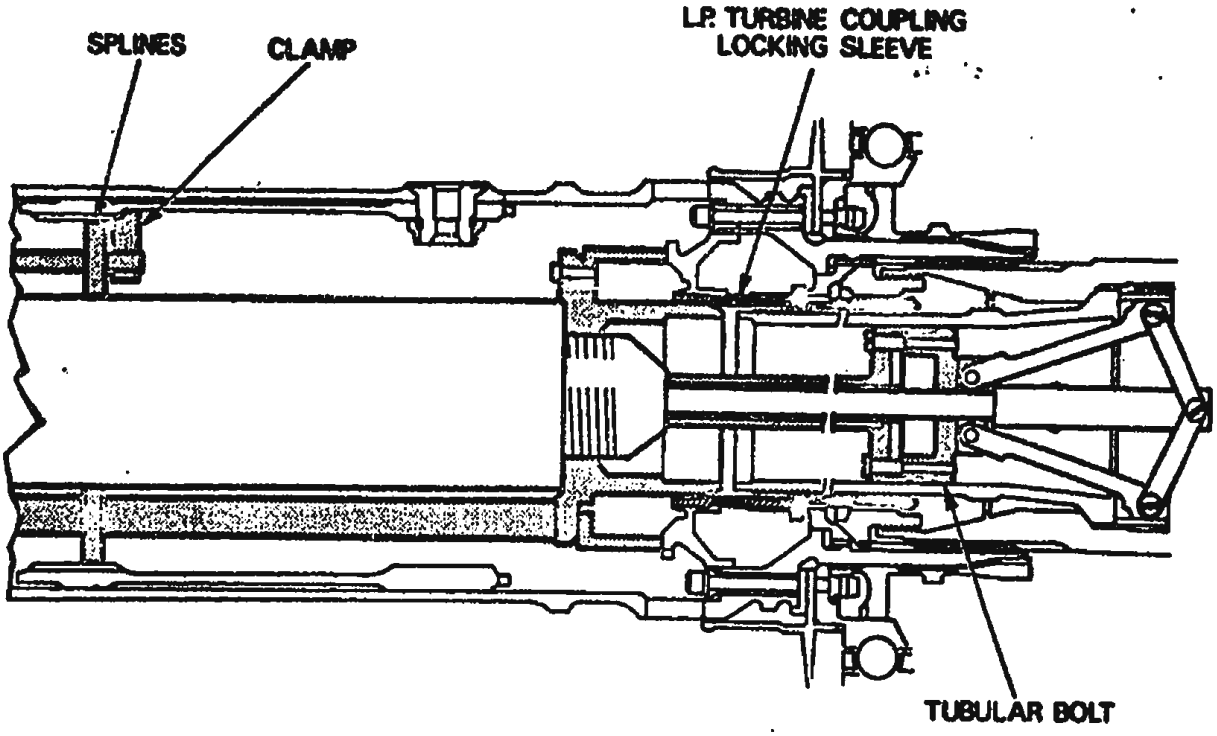

Method 1. Fit slave compressor shaft to turnover stand
Fig.405




Method 1. L.P. compressor disc slinging and support tooling
Fig.406, Sheet 1




R Method 2. L.P. compressor disc slinging and support tooling
R Fig.406, Sheet 2




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L.P. compressor disc slinging and support tooling
Fig.406, Sheet 3

(5) Position clamps of shaft pilot behind splines and tighten clamp nuts.

(6) Enter shaft pilot HU.20593/1 through pilot tool and screw in to thread at rear of pilot tool.

(7) Position slinging frame, CP.30042, and lifting tool, HU.20133/3, in work area.

(8) Secure ring, HU.21490, to rear of lifting tool.

(9) Secure lifting tool to slinging frame with four pins.

(10) Attach beam sling, CP.30072/1, to slinging frame at centre of gravity of combined tooling.

(11) Hoist tooling to position on shaft pilot.

(12) Traverse tooling rearward until lifting tool plate abuts compressor disc front flange.

(13) Align bolt holes in lifting tool with compressor disc flange nuts; fit and tighten lifting tool bolts to secure tooling.

(14) Transfer beam sling to centre of gravity of combined tooling and compressor disc.

R D. Method 2. Assemble and fit slinging and support tools, fig 406 (Sheet 2)

R (1) Insert the shaft pilot tool HU.27780 into the bore of the compressor and locate against the tubular bolts.

R (2) Slacken the expander nut of the retaining tool, HU.21395/1 fig 404, an amount sufficient to allow the tubular bolt to be moved rearward.

R (3) Push the shaft pilot tool into position locating in the L.P. turbine coupling locking sleeve while holding the retaining tool handle to keep the tubular bolt in abutment with the shaft pilot tool.

R (4) Tighten the expander nut of the retaining tool to clamp the tool and the bolt in the L.P. turbine shaft.

R (5) Position the clamps of the shaft pilot behind the splines and tighten the clamp nuts.

R (6) Enter the shaft pilot HU.20593/1 through the pilot tool
R and screw into the thread at the rear of the pilot tool.

R (7) Secure the ring HU.21490 to the rear of the lifting tool
R HU.20133/2.

R (8) Secure the lifting tool to the L.P. fan turnover sling
R CP.30745/1 with the 4 pins.

R (9) Hoist the L.P. fan turnover sling with the lifting tool
R to a position on the shaft pilot.

R (10) Traverse the tooling rearward until the lifting tool is
R against the front flange of the compressor disc.

R (11) Install and tighten the lifting tool bolts.

R E. Withdraw L.P. compressor disc and blades.

(1) Release and remove all disc/shaft curvic coupling bolts, using disassembly spanner, HU.20704/3.

(2) Traverse disc forward until clear of shaft pilot.

R F. Method 1. Install compressor disc in the storage or
R transportation container, fig.407 (Sheet 1).

(1) Lower compressor disc to position on slave shaft mounted in parking and turnover stand.

(2) Secure disc to slave shaft using slave shaft tool bolts.

(3) Transfer beam sling to centre of gravity of slinging frame.

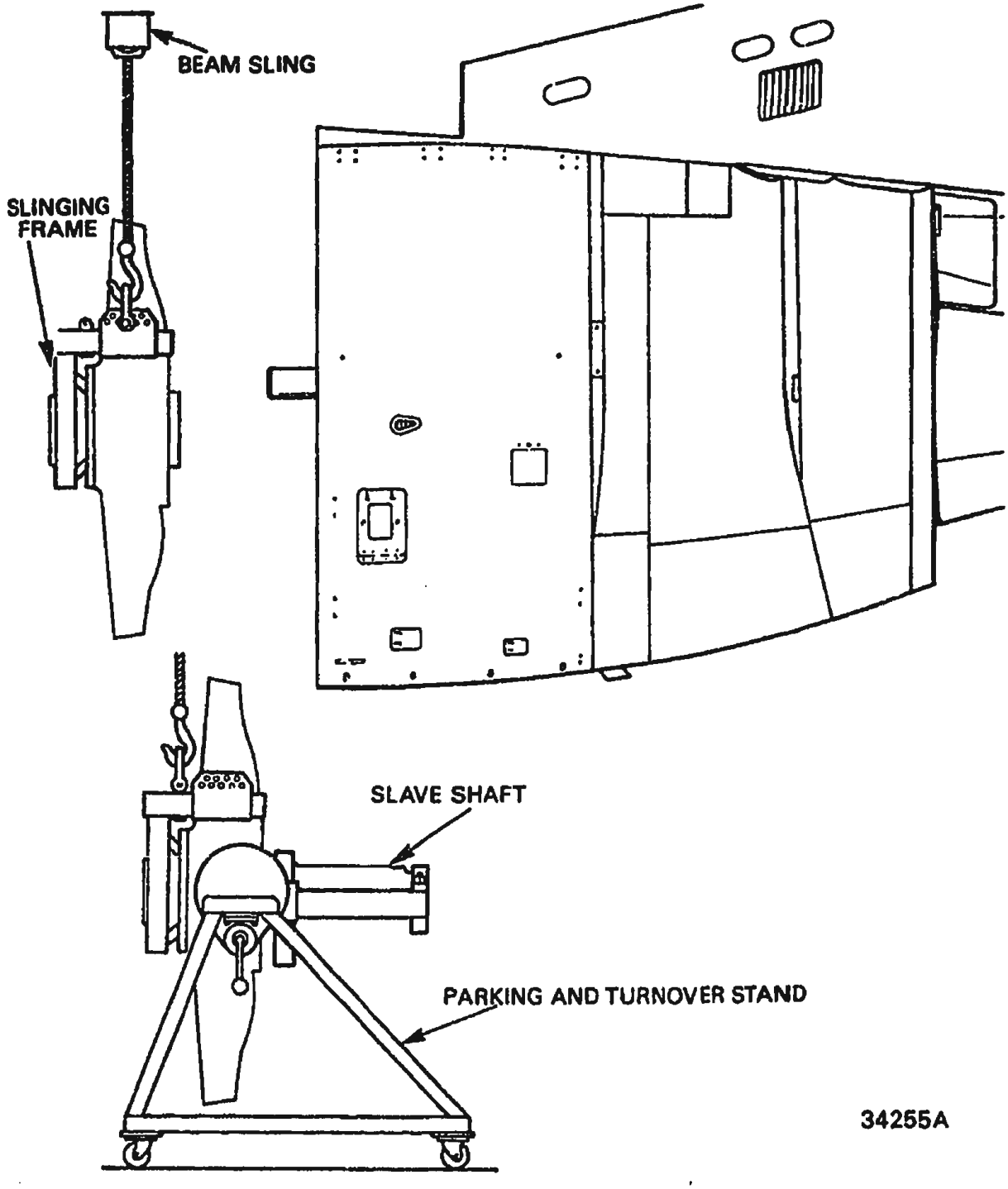
(4) Release and remove slinging frame from lifting tool and disc.

(5) Rotate turnover frame to bring compressor disc uppermost.

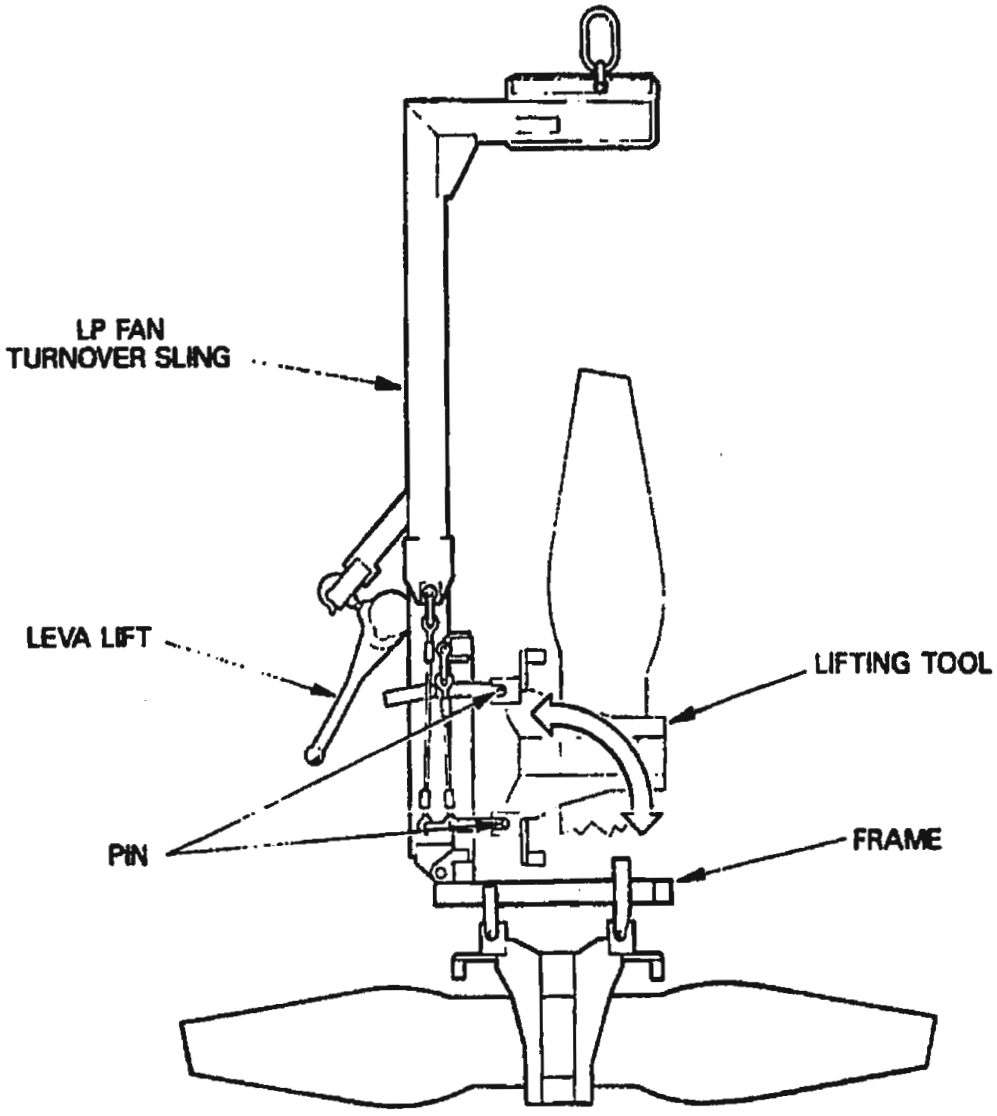
(6) Attach two-legged sling to hoist and secure sling to lifting eyes on lifting tool.

(7) Remove bolts securing disc to slave shaft and hoist disc clear of turnover stand.

(8) Lower disc to storage or transportation container.




Method 1. Remove/Install L.P. compressor disc
Fig.407 (Sheet 1)




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R Method 2. Remove/Install L.P. compressor disc
R Fig.407 (Sheet 2)

EFFECTIVITY: Engines 1 and 3

(9) Remove bolts securing lifting tool to compressor disc.

(10) Hoist lifting tool clear of disc and lower onto pallet.

(11) Remove sling from lifting tool.

R G. Method 2. Install the compressor disc in the storage or
R transportation container, fig 408 (Sheet 2)

R (1) Using the L.P. fan turnover sling move the compressor
R disc and blades to a horizontal position.

R (2) Lower the disc and blades into the storage or
R transportation container.

R (3) Remove the bolts securing the lifting tool to the disc.

R (4) Hoist the lifting tool clear of the disc and lower onto
R a pallet.

R (5) Remove the sling from the lifting tool.

5. Inspect the L.P. compressor disc and blades interfaces

A. Inspect the rear face of disc and blades

(1) Visually inspect interface for general condition, damage to seals, security of all bolts, washers, nuts, etc.

(2) Inspect curvic coupling teeth for cracks, galling and impact damage.

| | |
|---|---|
| (a) Cracked | Reject |
| (b) Galled or damaged | Repair, FRS.3253 (70-42-11) |

(3) Inspect fail-safe shaft outside diameters (fig.408 Sheet 2)

NOTE: The falling/scored limits quoted are the total depth of material loss allowed in relation to the unworn area of the shaft, irrespective of the number of times FRS.3253 has been applied.

(a) Galling - Outside diameter A

| | |
|---|---|
| (i) Up to a depth of 0.003in. (0,08 mm.) | Repair, FRS.3253 (70-42-11) |
| (ii) In excess of (i) | Reject |

(b) Scored - Outside diameter A

| | |
|---|---|
| (i) Up to a depth of 0.003in. (0,08 mm.) | Repair, FRS.3253 (70-42-11) |
| (ii) In excess of (i) | Reject |

(c) Galling - Outside diameter B

| | |
|---|---|
| (i) Up to a depth of 0.002in. (0,05 mm.) | Accept |
| (ii) In excess of (i) | Repair, FRS.3253 (70-42-11) |

(4) Inspect fail-safe shaft spherical diameter and outer surface and thrust ring face.

NOTE: The galling limits quoted for the spherical diameter are the total depth of material loss allowed in relation to the unworn area of the spherical surfaces irrespective of the number of times FRS.3253 is applied if the wear pattern is such as to preclude assessment of the depth, the shaft should be rejected.

(a) Galling

| | |
|---|---|
| (i) Galling to a depth of 0.003in. (0.076mm.) provided not more than 30% of the contact area is affected | Repair, FRS.3253 (70-42-11) |

(ii) Galling in excess of the above — Reject

(5) Inspect threads and load face of nut for pick-up

(a) Pick-up of threads and/or load faces — Repair, FRS.3253 (70-42-11)

(6) Inspect L.P. compressor rotor disc curvic coupling teeth for cracks, galling and impact damage

(a) Cracked — Reject

(b) Galled or damaged — Stone/hand polish 70-42-11, FRS.3253

(7) Inspect L.P. compressor rotor split driving ring assembly, 72-31-02 (01-240)

(a) Inspect the splines for cracks and galling

(i) Cracked — Reject

(ii) Galled — Stone/hand polish 70-42-11, FRS.3253

(b) Inspect the front face for galling around the bolt holes

(i) Galled — Stone/hand polish 70-42-11, FRS.3253

(c) Inspect rear face of integral spacers for galling

(i) Galled — Stone/hand polish 70-42-11, FRS.3253

(8) Visually inspect the rear stepped air seal for indications of rubbing

| | |
|---|---|
| (a) Light rubbing | Stone/hand polish 70-42-11, FRS.3253 |

B. Inspect the L.P. compressor rotor blade airfoils for damage, (Ref. 72-31-05).

C. Inspect the front face of I.P. compressor

(1) Visually inspect interface for general condition, damage to seals, security of all bolts, nuts, etc.

(2) Visually inspect static bore of rear stepped air seal for indications of rubbing

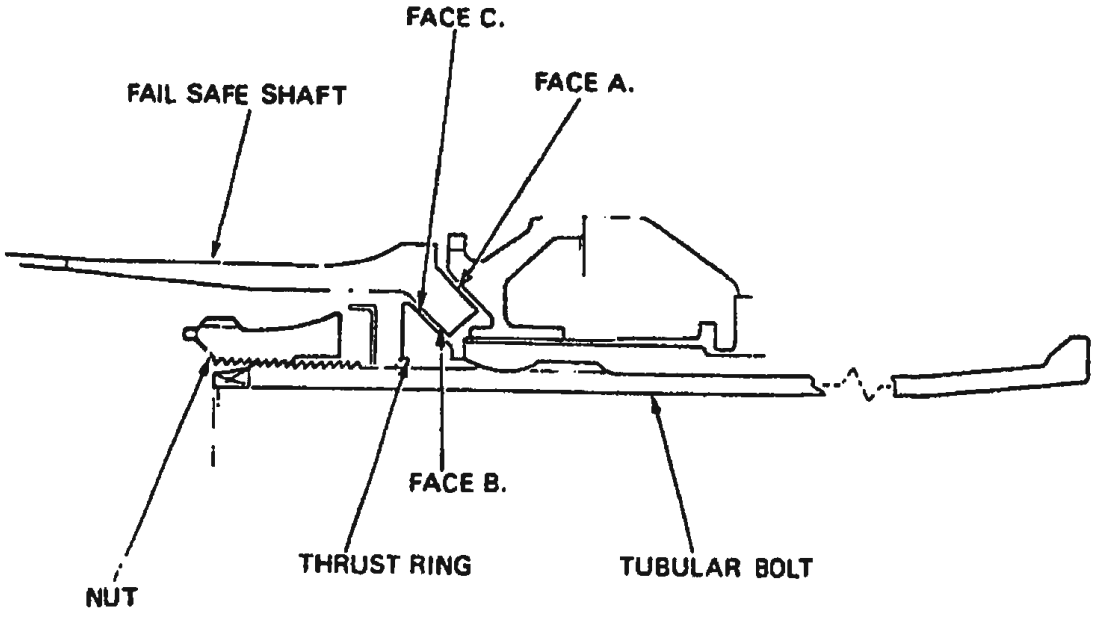
| | |
|---|---|
| (a) Light rubbing | Accept |

(3) Inspect the I.P. compressor fixed inlet guide vanes for dents and cracks

| | |
|---|---|
| (a) Dented and/or punctured, provided no secondary cracks | Accept |
| (b) A crack in the aerofoil which does not extend into an area 0.250in. (6,35 mm.) from the leading or trailing edges | Accept |

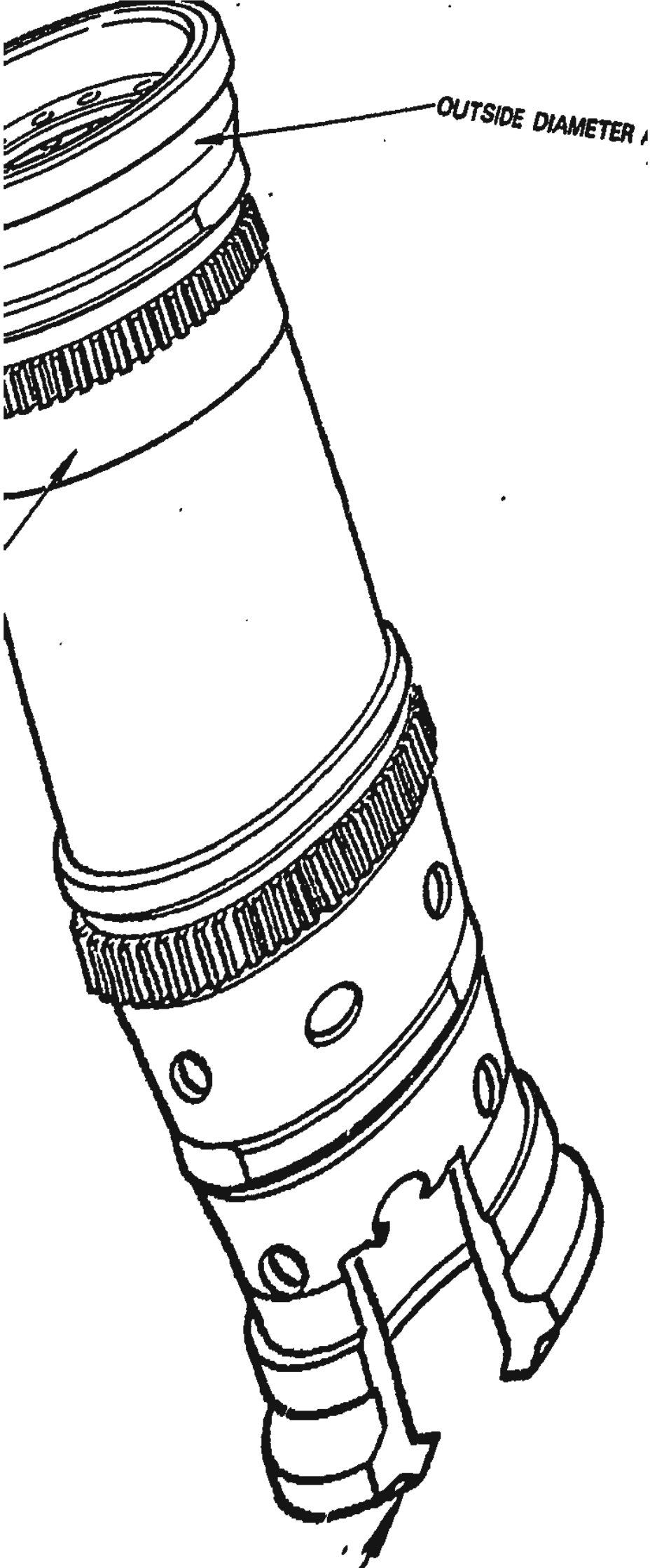
(4) Inspect the service tubes for dents and cracks

| | |
|---|---|
| (a) Dented provided no sharp edges or bottoms exist | Accept |
| (b) Cracked | Reject |




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Inspection areas on fail safe shaft, thrust ring, tubular bolt and nut
Fig.408 (Sheet 1)


OUTSIDE DIAMETER

(5) Check that metal seal ring is free to move in L.P. bearing inner race seal ring groove.

(6) Check that failsafe shaft support bush, is fitted to bore of L.P. compressor rotor shaft.

(7) Inspect L.P. compressor rotor shaft curvic coupling teeth for cracks, galling and impact damage.

| | | |
|---|---|---|
| (a) | Cracked | Reject |
| (b) | Galled or damaged | Stone/hand polish 70-42-11, FRS.3253 |

D. Inspect the L.P. compressor case and vanes (Ref. 72-31-01)

6. Prepare to install L.P. compressor disc and blades

R A. Method 1. Install compressor disc in parking and turnover
R stand, fig.407 (Sheet 1).

CAUTION: PRIOR TO INSTALLATION OF REPLACEMENT L.P. COMPRESSOR DISC AND BLADES THE TRIM BALANCE WEIGHTS (IF FITTED) MUST BE REMOVED.

(1) Position compressor disc in transportation container adjacent to turnover stand fitted with slave shaft.

(2) Attach two legged sling to hoist and secure sling to lifting eyes of lifting tool.

(3) Hoist lifting tool and fit in bore of compressor disc: fit lifting tool bolts to secure tool to disc.

(4) Hoist disc clear of transportation or storage container and lower to position on slave shaft.

(5) Fit and tighten slave shaft bolts to secure disc to slave shaft.

(6) Remove sling and hoist.

(7) Rotate turnover frame to bring compressor disc vertical.

(8) Attach beam sling, CP.30072/1, to slinging frame at centre of gravity of frame.

(9) Hoist frame to position on lifting tool and fit four pins to secure.

(10) Transfer beam sling to centre of gravity of combined tooling and disc.

R B. Method 2. Remove the compressor disc and blades from the
R storage or transportation container, fig.407 (Sheet 2).

R CAUTION: PRIOR TO INSTALLATION OF REPLACEMENT L.P.
R COMPRESSOR DISC AND BLADES THE TRIM BALANCE
R WEIGHTS, (IF FITTED) MUST BE REMOVED.

R (1) Attach the L.P. fan turnover sling to the lifting tool
R with the four pins.

R (2) Hoist the lifting tool and fit in the bore of the
R compressor disc: fit the lifting tool bolts to secure
R the tool to the disc.

R (3) Hoist the disc clear of the storage or transportation
R container.

R (4) Using the L.P. fan turnover sling move the disc and
R baldes to a vertical position.

R C. Inspect both halves of disc to shaft curvic coupling to ensure they are clean and free from damage.

7. Install L.P. compressor disc and blades

A. Materials required

| Material | British Spec. | American Spec. | OMat Item No. |
|---|---|---|---|
| Dry film lubricant (PL.94) | PJP4862X 6990 | - | 4/44A |
| Felt tip marker | - | - | 262 |
| Clean engine oil | - | - | 1011 |

B. Inspect mini-module interfaces /2 at split line as detailed in paragraph 5.

C. Measure shank of curvic coupling bolts, if length exceeds 2.895in. (73,533 mm.) reject bolts.

CAUTION: IT IS NECESSARY TO POSITION CORRELATION MARKS AS INSTRUCTED TO ENABLE THE MASTER BOLT HOLES IN THE DISC TO ALIGN WITH SIMILAR HOLES.

D. Correlate compressor disc and shaft

(1) Compressor disc (fig.411) correlation

(a) Using felt tip marker, mark correlations on splines in bore of driving ring.

(2) Compressor shaft (fig.412) correlation

(a) Using felt tip marker, mark correlations on shaft bore adjacent to the curvic teeth.

R E. Method 1. Fit and secure compressor disc, fig.406 (Sheet 1).

(1) Remove bolts securing disc to slave shaft.

(2) Hoist disc to position over shaft pilot.

(3) Traverse disc rearward, aligning correlation marks, until two halves of coupling are in engagement.

(4) Check curvic coupling for full engagement as follows:

(a) Using adjusting wrench (HU29179) locate special (plastic) bolt (HU29175) on wrench. Ensure square drive is locked.

(b) Install special bolts (Qty 3-off) in curvic coupling bolt holes at equi-distant positions, engage threads and screw bolts fully home.

NOTE: If special bolts will not engage threads, traverse disc forward to clear coupling, slightly rotate L.P. shaft and repeat checks until special bolts can be satisfactorily fitted.

(5) CAUTION: S.B.72-3132 INTRODUCES BOLTS OF EQUAL LENGTH TO SECURE BOTH PRE S.B.72-2958 and S.B.72-2958 STANDARD OF COMPRESSOR DISCS. BOLTS INTRODUCED BY S.B.72-2958 MUST NOT BE USED.

Apply clean engine oil to threads and mating faces of curvic securing bolts.

(6) Engage and run down curvic coupling securing bolts (32-off) using rundown spanner, XUT.41736, to light contact using the procedure and sequence defined 70-51-00. Remove special bolts.

(7) Engage and run down remaining curvic coupling securing bolts (3-off) as detailed in Item (6).

(8) Remove slinging frame and lifting tool.

(9) Using a mirror and lighting equipment check alignment of correlation marks on disc and compressor shaft.

(10) Spin rotor and re-check that all bolts are in light contact. If not, re-tighten as necessary.

(11) Fit lifting tool.

(12) Fit and secure index plate, HU.21468, to bosses on forward face of lifting tool, ensuring hole marked No.1 on index plate is at 9 o'clock position.

(13) Insert spanner, HU.21398/1, through bore of compressor disc and locate peg of spanner in hole No.1 in index plate.

(14) Tighten the curvic bolts by stages using sequence detailed in 70-51-00.

CAUTION: ALWAYS TIGHTEN BOLTS ON HORIZONTAL CENTRE LINE FIRST WHEN ASSEMBLING THE ENGINE HORIZONTALLY. WHEN THE FINAL TORQUE LOAD IS BEING APPLIED, IT IS ESSENTIAL THAT THE TORQUE READING ON THE SPANNER IS ALWAYS INCREASING. IF A CONSTANT OR DECREASING TORQUE IS OBSERVED, THE BOLT MUST BE REPLACED.

(a) Torque tighten bolts to initial value of 200 lb.in. (23 Nm). Spin the rotor and check that the torque value is still 200 lb.in. (23 Nm).

(b) Torque tighten bolts to intermediate value of 400 lb.in. (45 Nm). Spin the rotor and check that the torque value is still 400 lb.in. (45 Nm).

(c) Torque tighten bolts to final value of 1015 lb.in. (114.7 Nm) and spin the rotor.

(d) Starting at bolt/nut combination in hole 1 and proceeding in a clockwise direction, check each bolt/nut combination in turn to 1015 lb.in. (114,7 Nm).

(15) Remove spanner and index plate.

F. Method 2. Fit and secure the compressor disc, fig.406 (Sheet 2)

(1) Hoist the disc to a position over the shaft pilot.

(2) Traverse the disc rearward, aligning the correlation marks, until the two halves of the coupling are in engagement.

(3) Check the curvic coupling for full engagement as follows:

(a) Using the adjusting wrench (HU29179) locate the special (plastic) bolt (HU29175) on the wrench. Ensure the square drive is locked.

(b) Install the special bolts (Qty 3 off) in the curvic coupling bolt holes at equi-distant positions, engage the threads and screw the bolts fully home.

NOTE: If the special bolts will not engage threads, traverse the disc forward to clear the coupling and rotate the L.P. shaft slightly. Repeat the checks until the special bolts can be satisfactorily fitted.

(4) Apply clean engine oil to the threads and mating faces of the curvic securing bolts.

(5) Engage and run-down the curvic coupling securing bolts (32 off) using the run down spanner XUT41736 to light contact using the procedure and sequence defined in 70-51-00. Remove the special bolts.

(6) Engage and run down the remaining curvic coupling bolts (3 off) as detailed in item (5).

(7) Remove the turnover sling and the lifting tool.

(8) Using a mirror and lighting equipment check the alignment of the correlation marks on the disc and the compressor shaft.

(9) Spin the rotor and re-check that all the bolts are in light contact. If not re-tighten as necessary.

(10) Assemble and fit the lifting tool.

(11) Fit and secure the index plate HU21468 to the bosses on the forward face of the lifting tool, ensuring the hole marked No.1 on the index plate is at the 9 o-clock position.

(12) Insert the spanner HU21398/1 through the bore of the compressor disc and locate the peg of the spanner in hole No.1 in the index plate.

(13) Tighten the curvic couplings by stages using sequence detailed in 70-51-00.

CAUTION: ALWAYS TIGHTEN BOLTS ON HORIZONTAL CENTRE LINE FIRST WHEN ASSEMBLING THE ENGINE HORIZONTALLY. WHEN THE FINAL TORQUE LOAD IS BEING APPLIED, IT IS ESSENTIAL THAT THE TORQUE READING ON THE SPANNER IS ALWAYS INCREASING. IF A CONSTANT OR DECREASING TORQUE IS OBSERVED, THE BOLT MUST BE REPLACED.

(a) Torque tighten bolts to initial value of 200 lb.in. (23 Nm). Spin the rotor and check that the torque value is still 200 lb.in. (23 Nm).

(b) Torque tighten bolts to intermediate value of 400 lb.in. (45 Nm). Spin the rotor and check that the torque value is still 400 lb.in. (45 Nm).

(c) Torque tighten bolts to find value of 1015 lb.in. (114.7 Nm) and spin the rotor.

(d) Starting at bolt/nut combination in hole 1 and proceeding in a clockwise direction, check each bolt/nut combination in turn to 1015 lb.in. (114.7 Nm).

(14) Remove the spanner and index plate.

G. Method 1. Remove slinging and support tools, fig.406 (Sheet 1).

(1) Refit slinging frame to centre of gravity of combined tooling.

(2) Attach hoist and take weight.

(3) Release and remove bolts securing lifting tool to disc.

(4) Traverse tooling forward off pilot tool and lower to pallet.

(5) Remove beam sling.

(6) Unscrew and remove shaft pilot.

H. Method 2. Remove the slinging and support tools, fig.406 (Sheet 2)

(1) Attach the L.P fan turnover sling to the lifting tool with the four pins.

(2) Release and remove the bolts securing the lifting tool to the disc.

(3) Traverse the tooling forward off the pilot tool and lower onto a pallet.

(4) Unscrew and remove the shaft pilot.

J. Fit L.P. compressor fail-safe shaft

(1) Release shaft pilot tool clamps, XUT.38260/C or HU27780, fig.406.

(2) Slacken expander nut of retaining tool, HU.21395/1, fig.403, an amount sufficient to allow the tubular bolt to be moved forward.

(3) Pull shaft pilot tool forward holding retaining tool to keep tubular bolt in abutment with shaft pilot tool until tubular bolt is located in position, fig.403.

(4) Tighten expander nut of retaining tool to clamp tool and bolt in L.P. turbine shaft.

(5) Remove shaft pilot tool.

(6) Fit pilot bar, HU.21410, through bore of L.P. compressor rotor disc and shaft and engage fully on threads of tubular bolt, fig.403; tubular bolt has a left-hand thread.

(7) Fit installation cradle, HU.21675/2, and secure with clamps to rotor disc, fig.404.

(8) Fit and secure handle HU.26966, detail of HU.21675/2, to front end bore of fail-safe shaft.

(9) Apply dry film lubricant to load faces on rear of fail safe shaft.

(10) Fit and secure lifter, XUT.38280, to fail-safe shaft and attach hoist to lift shaft into installation cradle.

(11) Secure fail-safe shaft to sliding support.

(12) Release and remove lifter, XUT.38280, and hoist.

(13) Guide fail-safe shaft rearward on installation cradle and engage rear end of shaft on pilot bar, HU.21410.

(14) Continue to guide shaft rearward until fully entered in bore of L.P. compressor rotor shaft.

(15) Release and remove installation cradle.

(16) Remove pilot bar; left-hand thread.

(17) Fit thrust ring, cupwasher and nut to retaining bolt.

R NOTE: A new cupwasher must be installed.

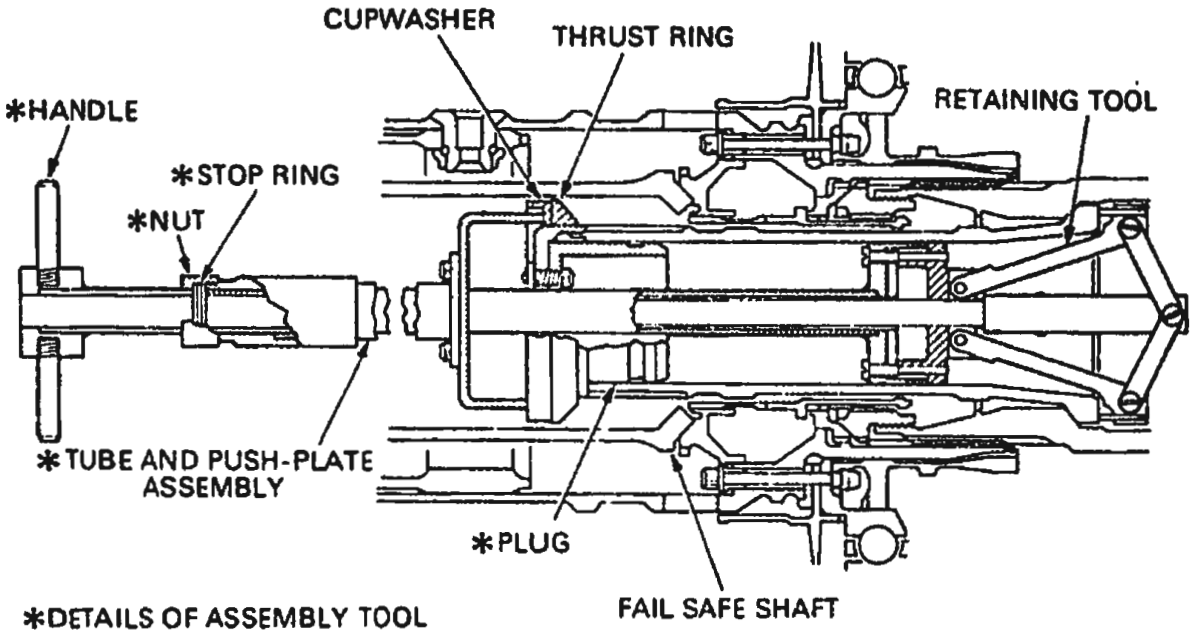
(a) Apply dry film lubricant to threads of tubular retaining nut and to load faces of nut, thrust ring and cupwasher.

(b) Fit thrust ring and cupwasher to assembly tool, HU.21397, as detailed in fig.411.

(c) Fit thrust ring and cupwasher to tubular retaining bolt, fig.409.

(d) Fit support, HU.20055 or HU.26565, to front flange of fail-safe shaft, fig.402.

(e) Enter immobiliser, HU.19565/3, through bore of fail-safe shaft, engage in bore of tubular bolt and locate dogs at forward end of bolt, fig.402.




*DETAILS OF ASSEMBLY TOOL

1 Engage nut to retain tube and push-plate assembly in contact with stop ring
2 Fit cupwasher and thrust ring to plug
3 Pass assembly tool through bore at front of assembled L P compressor rotor and locate in bore of assembled tubular bolt
4 Locate thrust ring and cupwasher dogs in tubular bolt slots
5 Release nut
6 Push thrust ring and cupwasher on to tubular bolt and into full contact with fail-safe shaft
7 Withdraw assembly tool

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Fit thrust ring and cupwasher to shaft retaining bolt
Fig.409

(f) Fit nut to socket adapter, HU.19564/1, and guide socket adapter over assembled immobiliser to engage nut on threads of tubular bolt; tubular bolt has left-hand thread.

(g) Fit reduction gearbox, 1704300, to socket adapter, HU.19564/1, fig.402.

(h) Fit anchor plate, HU.12763, to reduction gearbox then fit and secure information plate, HU.21403, fig.402, sheet 2.

(i) Torque tighten tubular bolt and retaining nut to 500 lb.ft. and temporarily mark reduction gearbox.

NOTE: Tubular bolt has left-hand thread.

(j) Release retaining nut.

(k) Torque tighten retaining nut to 500 lb.ft. and ensure alignment of temporary marks on gearbox.

If marks do not align, erase marks repeat items (9) to (11) until satisfactory alignment is acheived.

(e) Remove information plate, anchor plate, reduction gearbox, immobiliser, socket adapter, support and retaining tool.

(m) Unscrew expander nut to collapse retaining tool expander legs then remove retaining tool; screw clamp nut on to retaining tool.

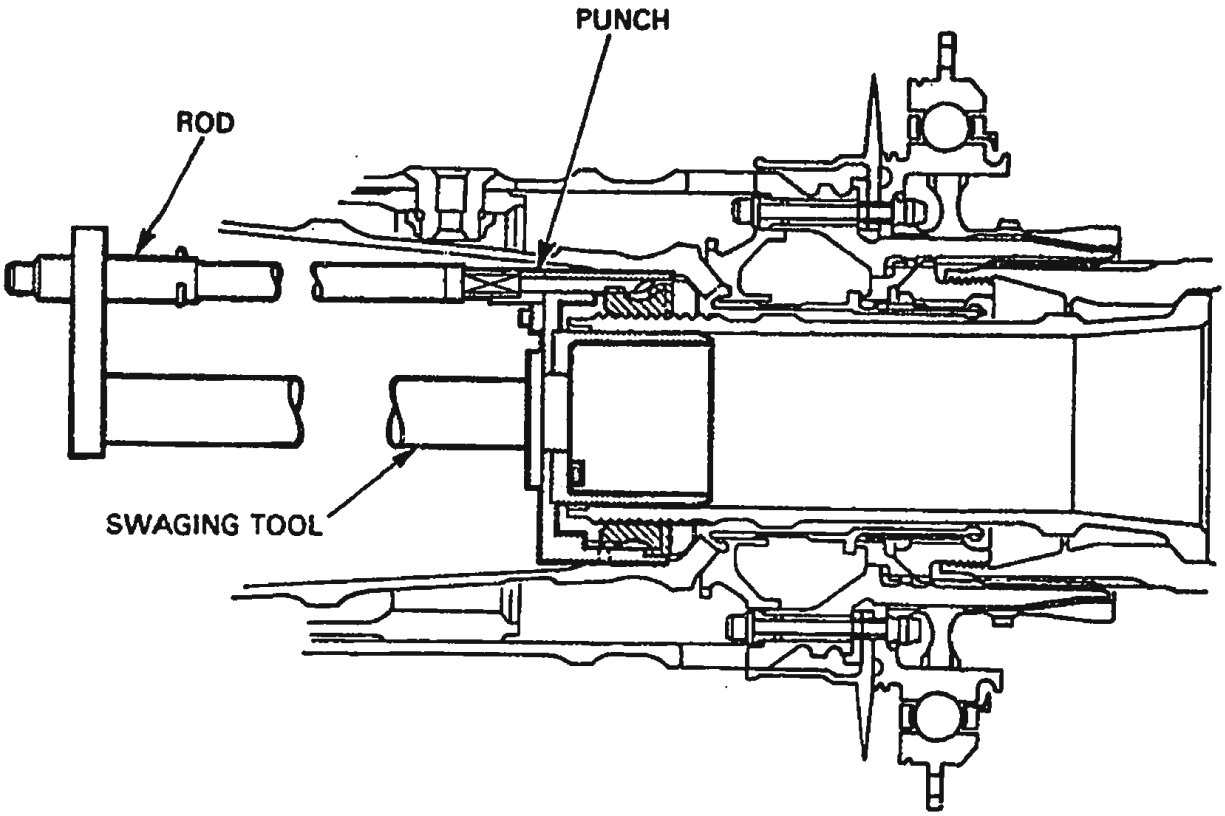
(18) Lock fail-safe shaft retaining nut, fig.410

(a) Fit punch, HU.20073, to swaging tool, HU.20072/2.

(b) Enter swaging tool through bore of fail-safe shaft, align punch with scallop in nut and engage tool in bore of tubular bolt.

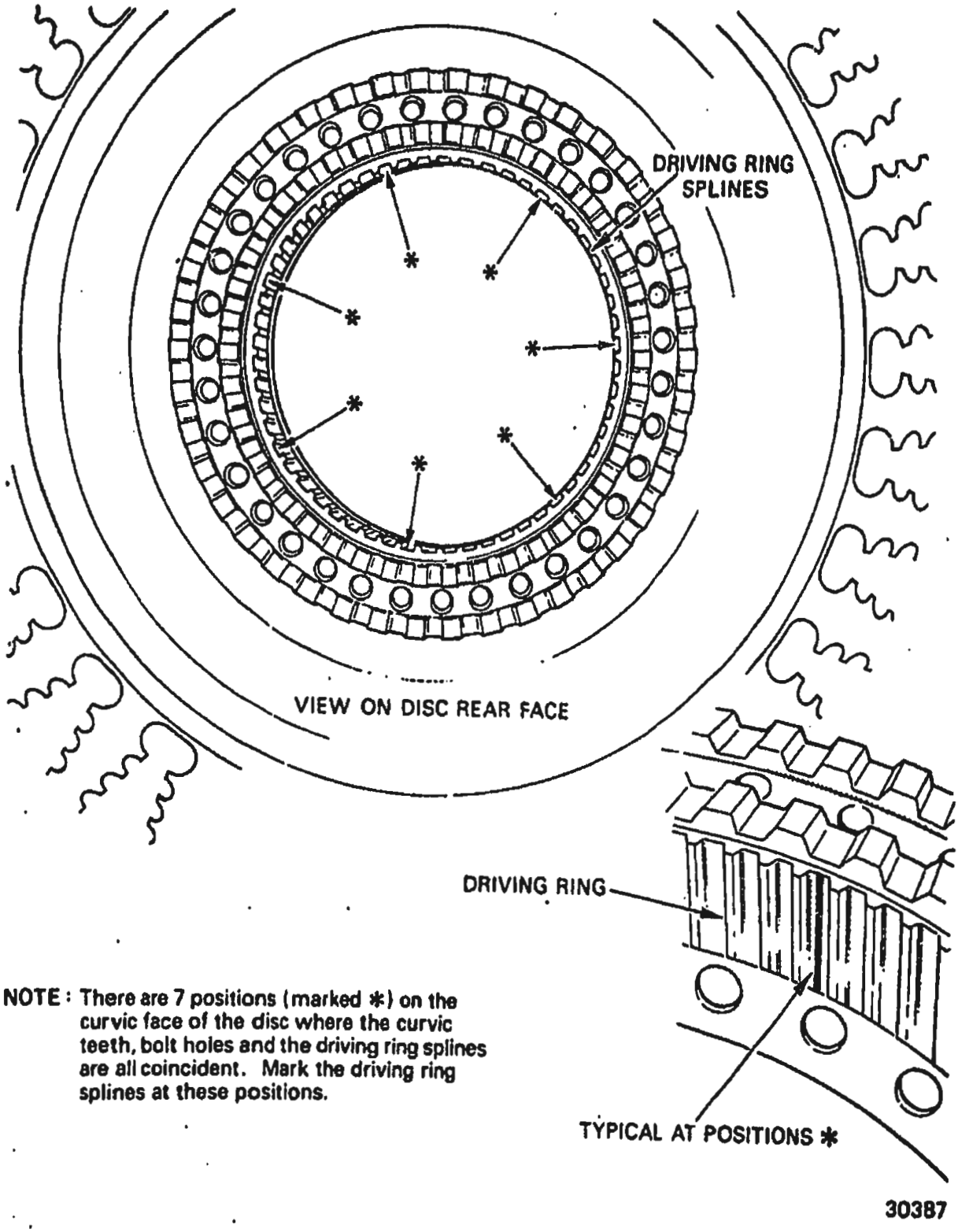
(c) Strike outer end of rod with hammer to depress cupwasher rim into nut scallop.

(d) Withdraw swaging tool and rotate to align punch with scallop in nut directly opposite to previously locked position and engage tool in bore of tubular bolt.



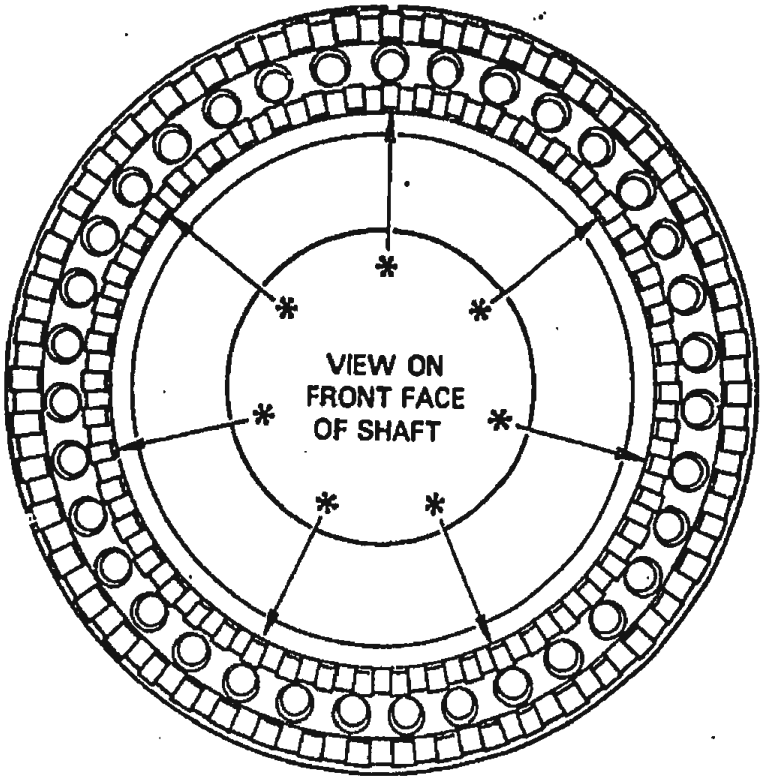

34258A

Lock fail-safe shaft retaining nut
Fig.410

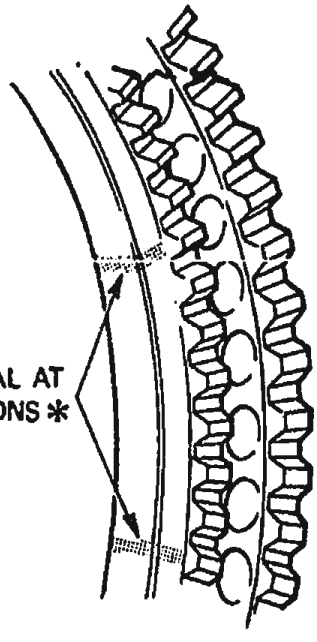



NOTE : There are 7 positions (marked *) on the curvic face of the disc where the curvic teeth, bolt holes and the driving ring splines are all coincident. Mark the driving ring splines at these positions.

Compressor disc correlation
Fig.411




NOTE : There are 7 postions (marked *) on the curvic face of the shaft where the curvic teeth and bolt holes are coincident, mark the bore at these positions




30487A

Compressor shaft correlation
Fig.412

(e) Strike outer end of rod with hammer to depress cupwasher rim into nut scallop.

(f) Remove swaging tool.

K. Fit L.P. compressor spinner and anti-icing tube, (Ref. 72-31-03).

8. Install nose cowl

A. Inspect nose cowl to fan case interface

(1) Inspect nose cowl rear face.

(a) Visually inspect nose cowl rear face for general condition and security of tube clips, unions, electrical connectors etc.

(b) Inspect the attachment flange locating dowels for security and burrs

| | |
|---|---|
| Loose dowels | Tighten |
| Burrs | Stone/hand polish 70-42-11, FRS.3253 |

(c) Inspect nose cowl attachment flange for burrs

| | |
|---|---|
| Burrs | Stone/hand polish 70-42-11, FRS.3253 |

(2) Inspect fan case front flange

(a) Inspect front flange front face for burrs

| | |
|---|---|
| Burrs | Stone/hand polish 70-42-11, FRS.3253 |

(b) Inspect captive nuts for damaged threads and/or loose retainers

Damaged threads and/or loose retainers — Repair 70-42-19, FRS.3035

B. Fit nose cowl, fig.401

CAUTION: THE NOSE COWL ASSEMBLY WEIGHS APPROXIMATELY 540 LB. (245 KG).

(1) Material Required:

| | British Spec/Ref. | American Spec/Ref. | OMat Item No. |
|---|---|---|---|
| Lockwire | DTD.189A 22 S.W.G. | - 21 A.W.G. | 238 |

(2) Position nose cowl in parking stand in work area.

(3) Attach sling, CP.20091/1, to hoist and slinging points on nose cowl.

(4) Take weight of nose cowl on hoist and remove bolts securing cowl to stand.

(5) Lift nose cowl and align locating dowels.

(6) Move cowl rearwards until rear face abuts front face of fan case.

(7) Fit washers and bolts to secure nose cowl to fan case.

(8) Torque tighten bolts to standard loading.

(9) Remove sling from nose cowl and hoist.

(10) Connect anti-icing duct with coupling clamp and torque load clamp, Ref.70-12-02.

(11) Connect electrical connectors, fire bottle discharge harness connectors and pip pins.

(12) Connect P1 air tube, torque load connector to standard loading and wirelock.

C. Close left-hand and right-hand hinged cowls, 71-11-00.

9. Test Q.E.C. unit

Test Q.E.C. unit as detailed in Aircraft Maintenance Manual 71-00-00, Adjustment/Test.

# LOW PRESSURE (L.P.) COMPRESSOR DISC AND BLADES - REMOVAL/INSTALLATION

## MINI-MODULE 01/1

## INSTALLED FUSELAGE MOUNTED POWER PLANT

Referenced Procedures:

| | |
|---|---|
| 72-31-03 | Spinner and anti-icing tube - removal/installation |
| 72-31-05 | L.P. compressor rotor blades - inspection/check |
| 72-31-01 | L.P. compressor case and vanes - inspection/check |

## 1. General

For standard torque loadings and torque tightening technique, refer to 70-51-00.

Special torque loadings and assembly tolerances are detailed at the appropriate stage of the procedure.

Discard all rubber seal rings and key washers removed during removal sequence.

For identification, lubrication and fitting of rubber seal rings, refer to 70-02-01.

For information on fitting of Vee-band coupling clamps, refer to 70-12-02.

On completion of assembly, joint flanges, securing features and any area where surface protection is damaged or deteriorated must be re-protected by applying air drying enamel of the appropriate colour. The air drying enamels required are listed in 70-42-12.

Positional relationship is based on engine in flight position. Detailed radial locations are numbered in a clockwise direction starting from engine top position and viewed from rear unless otherwise specified.

## 2. Equipment required

| | Part No. | Description |
|---|---|---|
| * | BA86-101 | Cover No.2 engine inlet duct |
| * | B672 | Workstand, engine No.2 |
| | DPD 30020 | |
| | HU.20747/1 | Extractor, anti-icing tube support cone |
| | HU.20055 | Support (Pre S.B.72-4917) |
| | or | |
| | HU.26529 (S.B.72-4917) | |
| | HU.19564 | Adapter socket |
| | (SWE.10673) | |
| | HU.19565/3 | Immobiliser |
| | (SWE.10473) | |
| | HU.21395/1 | Tool, retaining |
| | HU.21402 | Nose |
| | 1704300 | Gearbox, reduction, Sweeney |
| R | or | |
| R | 1012394 | |
| | HU.12763 | Plate, anchor |
| | HU.21403 | Plate, information |
| | HU.21410 | Bar, pilot |
| | HU.21675/2 | Cradle, installation |
| | HU.26966 | Handle |
| | HU.21396 | Handle |
| | XUT.42395 | Sleeve, protection |
| | XUT.38280 | Lifter |
| * | BG.32 | Davit assembly, S duct adapter |
| * | B.676 | Dolly, air intake adapter |
| * | BG.34 | Sling assembly, air intake adapter |
| * | PNWE.3981 | Hoist, portable (2 off required) |
| | (Wadell | |
| | Equipment Co) | |
| * | BG.31 | Hoist assembly, bootstrap |
| * | 1305269-101 | Frame, slinging |
| | HU.20133/3 | Tool, lifting |
| | HU.21490 | Ring |
| * | BG.33 | Platform, working |
| | HU.20704/3 | Spanner, disassembly only |

| | |
|---|---|
| XUT.41736 | Spanner, run-down only |
| HU.21468 | Plate, index |
| HU.21397 | Tool, assembly |
| HU.20073 | Punch |
| HU.20072/2 | Tool, swaging |
| HU.21398/1 | Spanner, torque tightening only |
| HU.29175 | Bolt dummy (Qty 3 - off) |
| HU.29179 | Wrench, adjusting |

* Lockheed Aircraft recommended tooling

3. Prepare to remove L.P. compressor disc and blades

WARNING: WHEN WIND CONDITIONS PREVAIL, THE NO.2 ENGINE INLET DUCT COVER MUST BE INSTALLED TO PREVENT FAN WINDMILLING.

A. Install No.2 engine inlet duct cover, BA.86-101, as required.

B. On pilots overhead ENGINE START panel, zone 210, tag applicable engine start switch.

C. On Flight Engineers/Second Officers aft circuit breaker panel CB3, zone 215, open and tag circuit breaker PROXIMITY SWITCH 2 (H3).

D. Retract tail skid

WARNING: VERIFY THE FOLLOWING BEFORE PRESSURIZING ANY HYDRAULIC SYSTEM:

LANDING GEAR DOWNLOCK SAFETY PINS AND DOOR SAFETY DEVICES ARE INSTALLED.

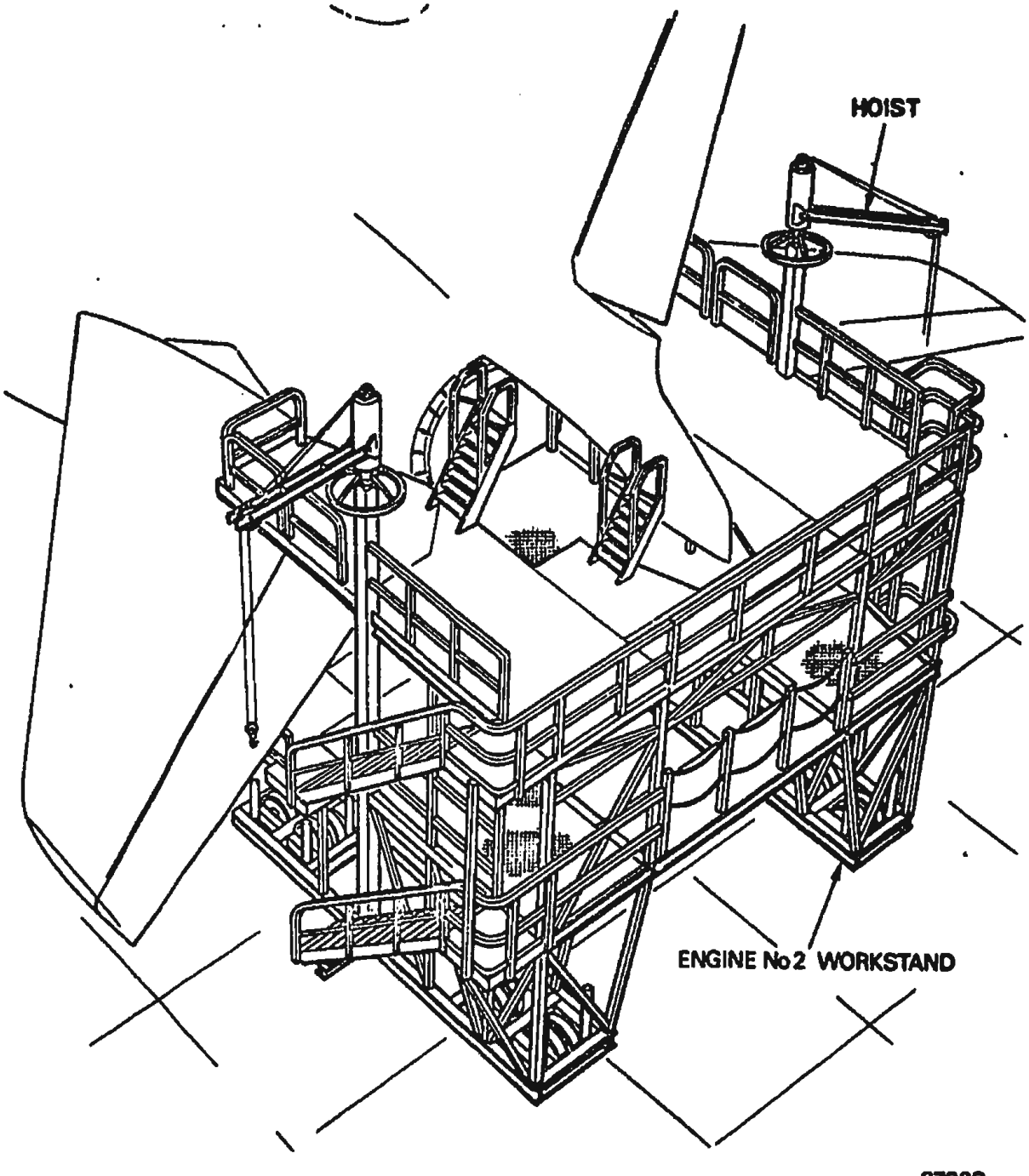
TRAVEL AREAS OF ALL FLIGHT CONTROL SURFACES AND MAIN GEAR DOORS ARE CLEAR OF PERSONNEL AND GROUND EQUIPMENT.

THE AFFECTED HYDRAULIC SYSTEMS CAN ACCEPT HYDRAULIC PRESSURE.

(1) Connect external power source to receptacle on forward lower fuselage, zone 124 (FS458).

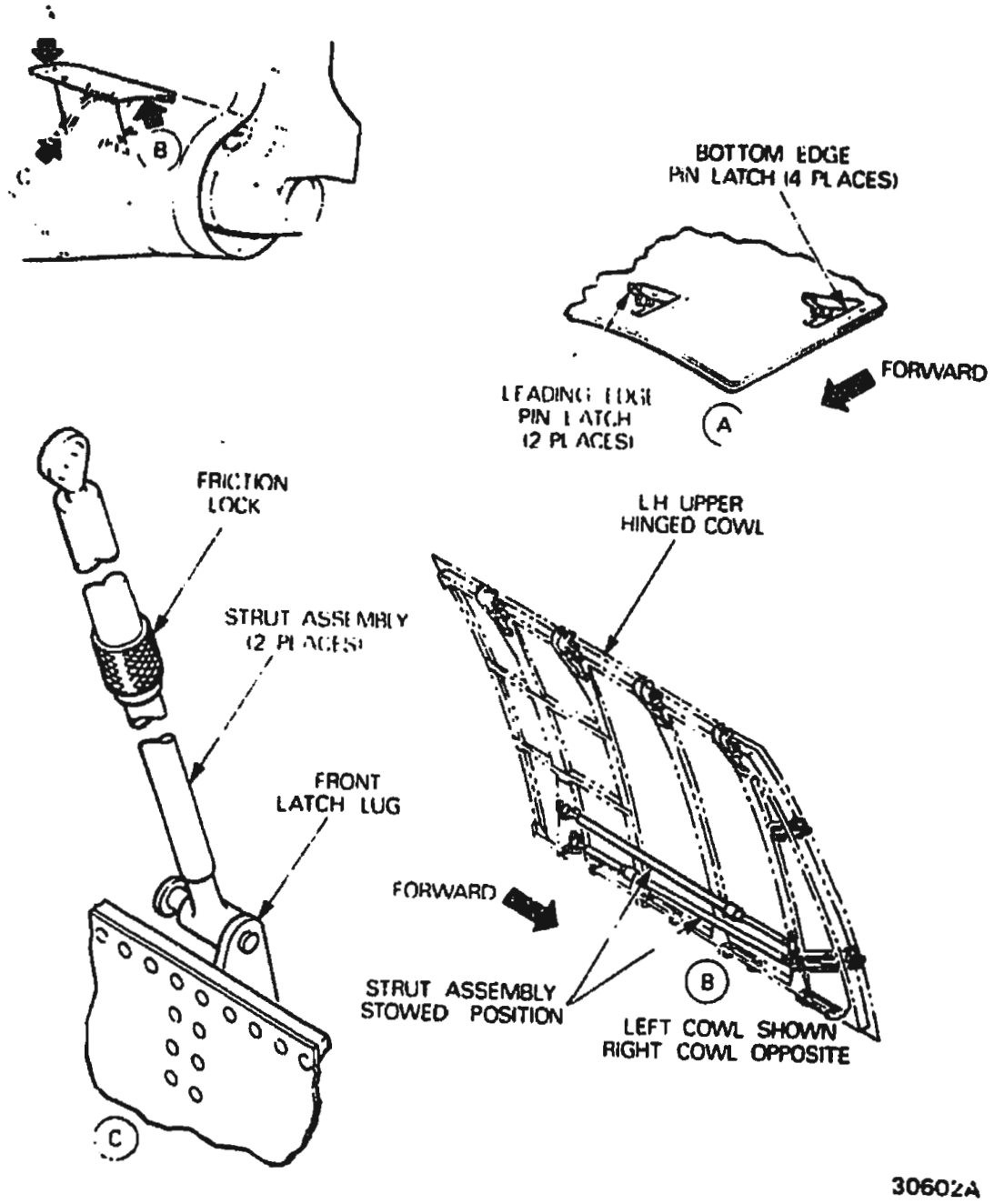
NOTE: External power source must be capable of supplying 115/200V ac, 3-phase, 400-Hz, ABC phase rotation with a capacity of 90 kVa continuous.

(2) Energize external power source.




R Engine work stand
R Fig.401

R EFFECTIVITY: Engine 2




R Open/Close L.H. and R.H. upper hinged cowls
R Fig.402

R EFFECTIVITY: Engine 2

R
R
R
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(3) Energize aircraft buses using the following procedure:

(a) Check that EXT POWER AVAIL and EXT POWER NOT IN USE lights come on; lights are located on Flight Engineers/Second Officers electrical control panel, zone 215, and in receptacle area.

(b) Place volts-frequency selector switch in EXT POWER position and check for correct voltage and frequency as indicated on adjacent voltage and frequency meters.

(c) Place essential bus selector switch in NORM B3-(G1) position.

(d) Place EXT PWR switch in ON position and check that ON indication (above switch) comes on, AVAIL light remains on and NOT IN USE light (in receptacle area) goes off.

(4) Open hydraulic service centre access doors 147AB and 147BB to operate HYDRAULIC SERVICE PANEL controls or gain access to Flight Engineers/Second Officers HYDRAULIC SYSTEM control panel, zone 215.

(5) Pressurize hydraulic system A as follows:

To pressurize system from hydraulic service centre.

(a) Place B SYS MOTOR PUMP toggle switch to ON, and B to A PTU momentary switch to START.

To pressurize system from Flight Engineers/Second Officers panel:

(b) Depress B3 AC PUMP and B-A PTU switchlights to ON.

(6) Open panel 318BA and place tailskid ground service switch to RETRACT position; verify that tailskid retracts.

NOTE: Verify that tailskid switch warning flag is visible.

(7) Shut off hydraulic system A pressure as follows:

(a) Hydraulic service centre

Place HYDRAULIC SERVICE PANEL switches to OFF/STOP and rotate RESERVOIR SELECTOR switch to OFF.

(b) Flight Engineers/Second Officers panel

Release applicable Flight Engineers/Second Officers HYDRAULIC SYSTEM panel switches (light out).

(8) Turn off electrical power

Place all associated switches, including BATTERY switch, in OFF position then de-energize and disconnect external power source.

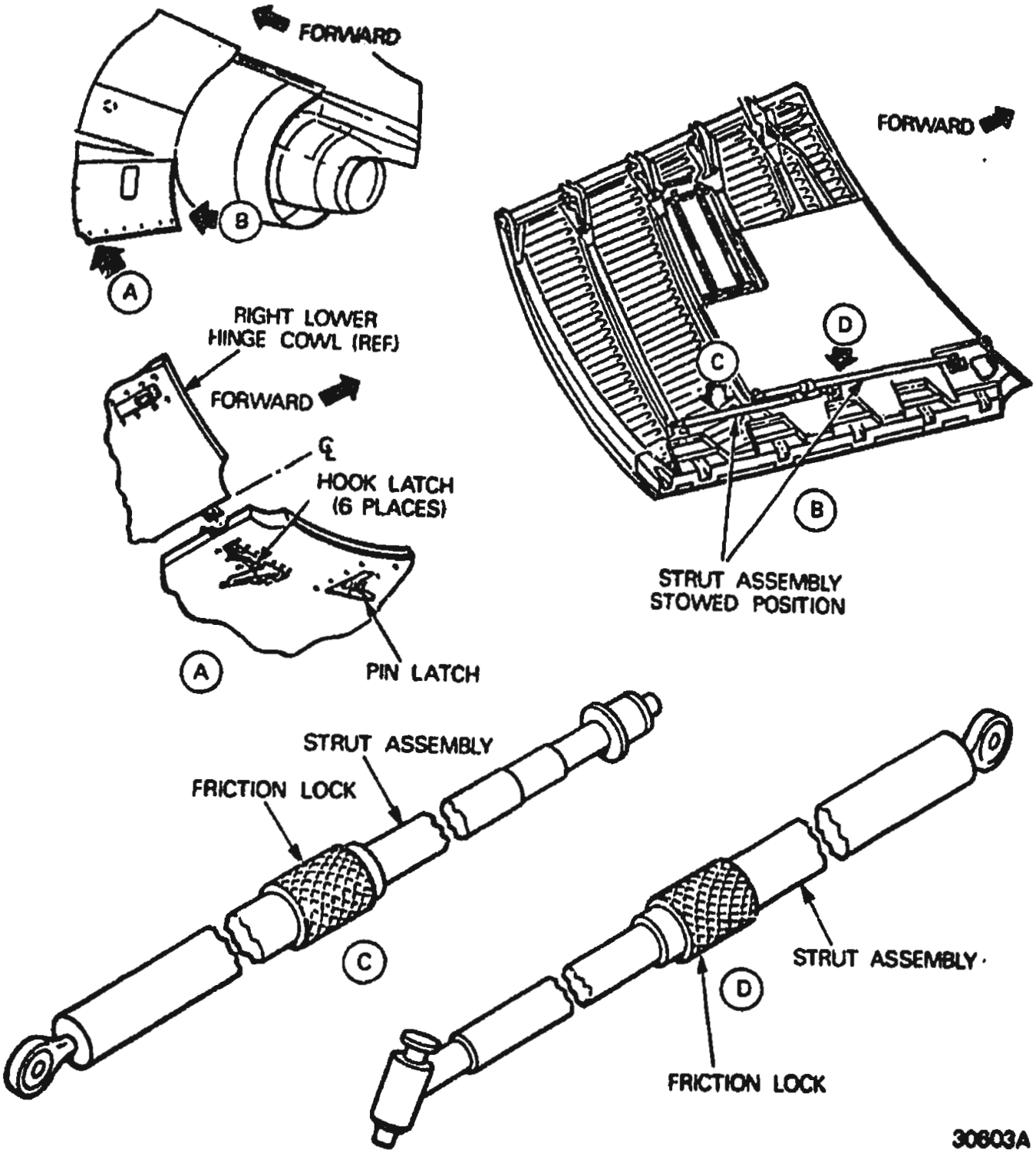
E. Open left-hand (L.H.) and right-hand (R.H.) upper hinged cowls:

WARNING: AVOID OPENING HINGED COWL PANELS WHEN STRONG WINDS OR GUST CONDITIONS EXIST.

(1) Position workstand, B.672 or DPD.30020, for access to upper hinged cowl panels, fig.401.

(2) Release pin latch assemblies along forward and lower edges of cowl panel, fig.402.

(3) Open cowl then release cowl panel strut assemblies from retaining brackets.




Open/Close L.H. and R.H. lower hinged cowls
Fig.403

(4) Extend struts and lock in fully extended position with friction locks, fig.402.

(5) Attach struts to anchorage fittings

NOTE: The anchorage fittings are located on the engine for the rear strut and on the aft canted bulkhead for the front strut.

(6) Ensure that struts are secure and locked then release cowl panel.

F. Open L.H. and R.H. lower hinged cowls

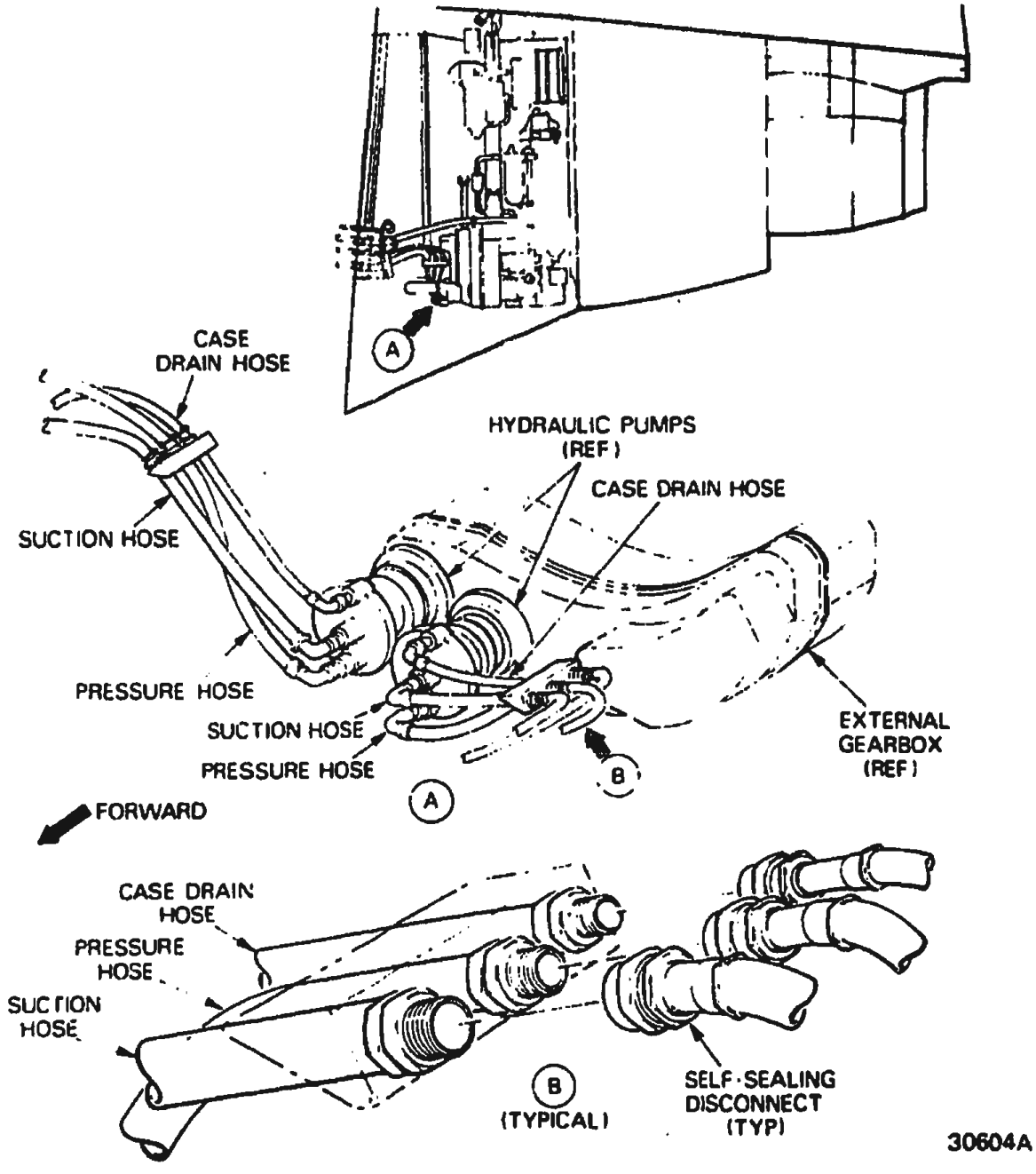
WARNING: AVOID OPENING HINGED COWL PANELS WHEN STRONG WINDS OR GUST CONDITIONS EXIST.

(1) Release forward pin latch and hook-type latches along lower edge of cowl panel, fig.403.

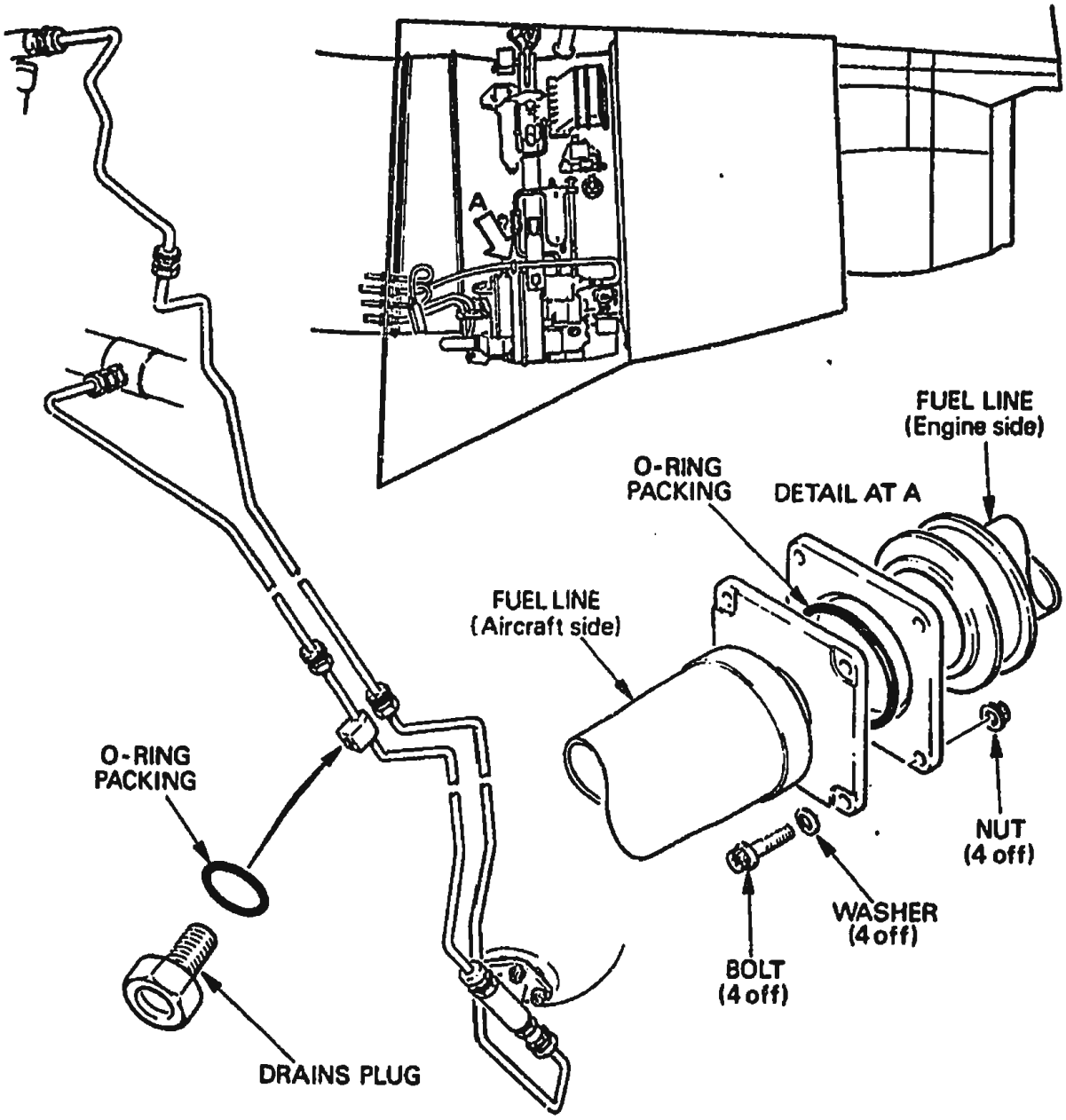
NOTE: Both lower hinged cowls must be supported until all latches are disengaged.

(2) Allow both lower hinged cowls to open.

(3) Tie or brace cowl panels open wide enough to allow clearance for removal of air intake adapter.

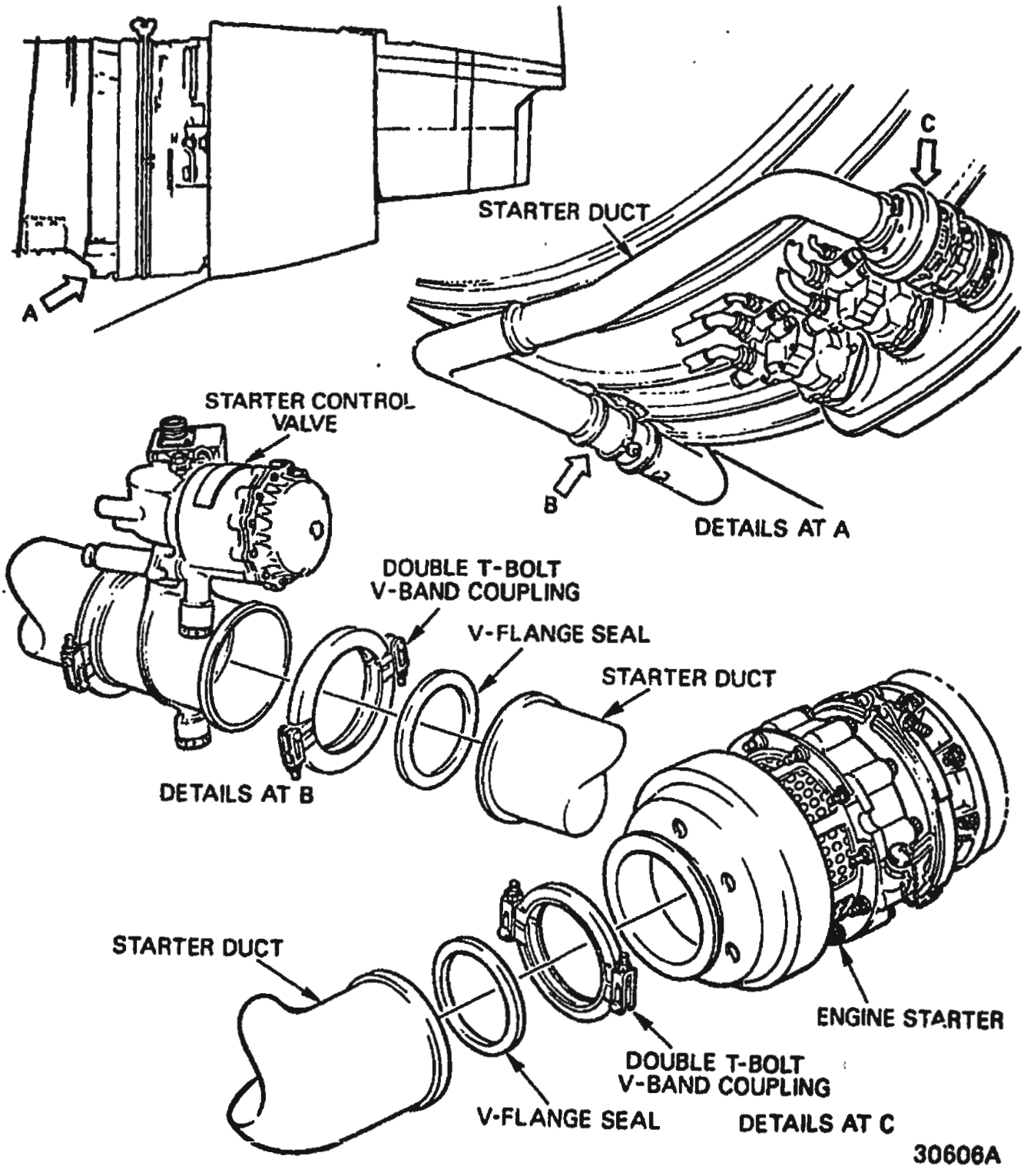



R Hydraulic disconnects
R Fig.404




R
R

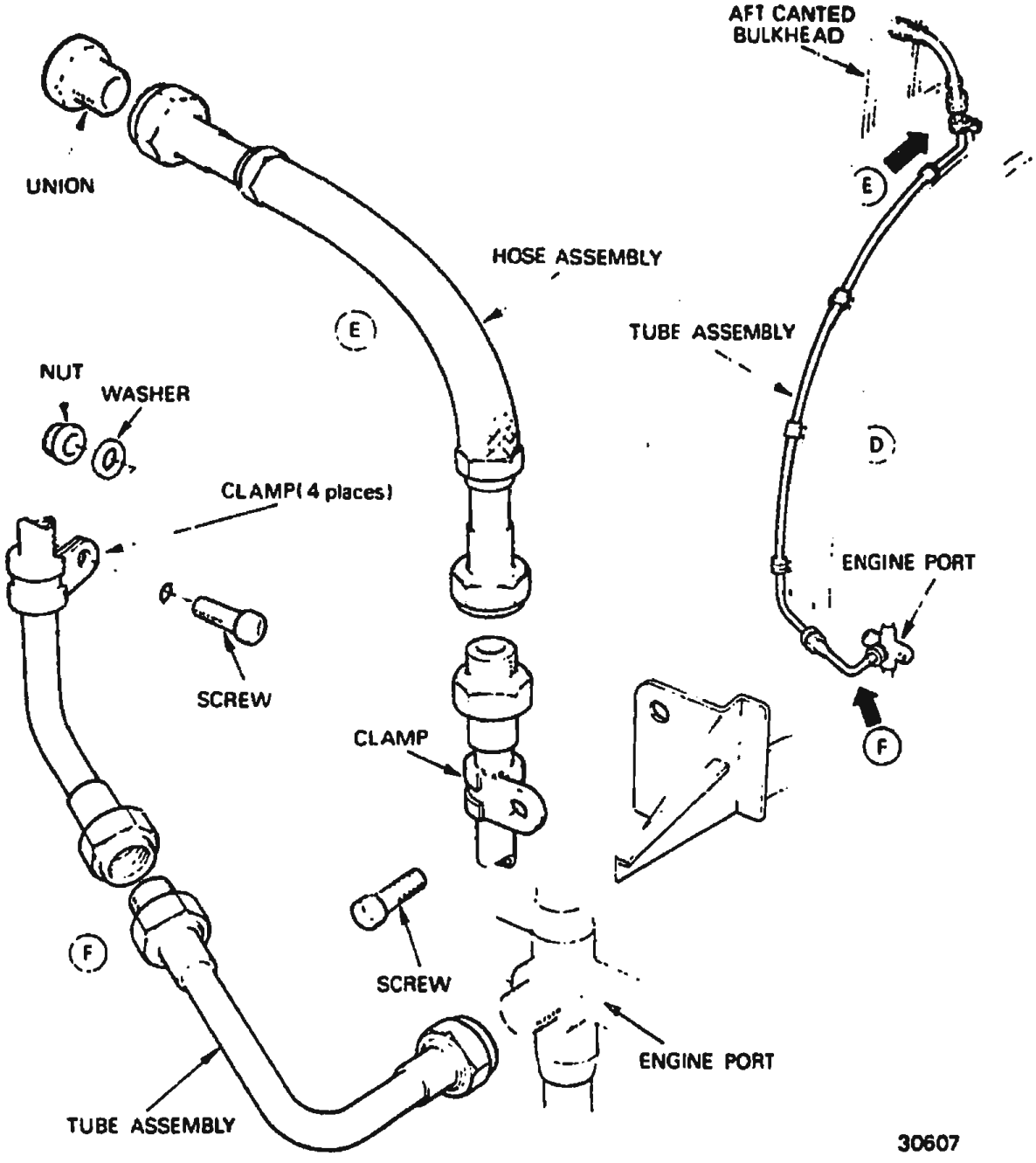
Fuel line disconnect
Fig.405




R R Remove/Install starter ducting
Fig.406

R EFFECTIVITY: Engine 2

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R P1 probe tube assembly
R Fig.407

R EFFECTIVITY: Engine 2

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G. Remove air intake adapter.

(1) Disconnect B1 and C1 pump hydraulic lines at the self-sealing disconnects, fig.404, and fit protective caps.

(2) Remove fuel drain plug, fig.405, from fuel supply line and drain fuel into container; refit drain plug, torque tighten to standard loading and wirelock.

(3) Disconnect fuel line, fig.405, and fit protective caps; temporarily support fuel line to prevent kinking and damage.

(4) Remove coupling clamp securing starter duct to engine starter, fig.406.

(5) Remove coupling clamp securing starter duct to starter control valve, fig.406; remove starter duct.

(6) Remove L.P. compressor spinner and anti-icing tube, (Ref. 72-31-03).

(7) Disconnect proximity switches and wire harness from air intake adapter access door.

(8) Disconnect P1 probe tube assembly and disconnect clamps from adapter, fig.407.

(9) Loosen fire detector loop clamps at aft canted bulkhead to allow moving loop for clearances during removal of air intake adapter.

(10) Install davit assemblies, BG.32, in applicable holes of mid fixed cowl beams, centering davits with air intake adapter, fig.408 (Sheet 1).

(11) Position adapter dolly, B.676, fig.408 (Sheet 1), under engine.

(12) Attach air intake adapter sling, BG.34, to adapter, fig.408 (Sheet 2 and 3).

(13) Attach portable hoists, PNWE.3981, to davit assembly arms, fig.408 (Sheet 1).

(14) Unwind portable hoist cables and attach cables to adapter sling end fittings.

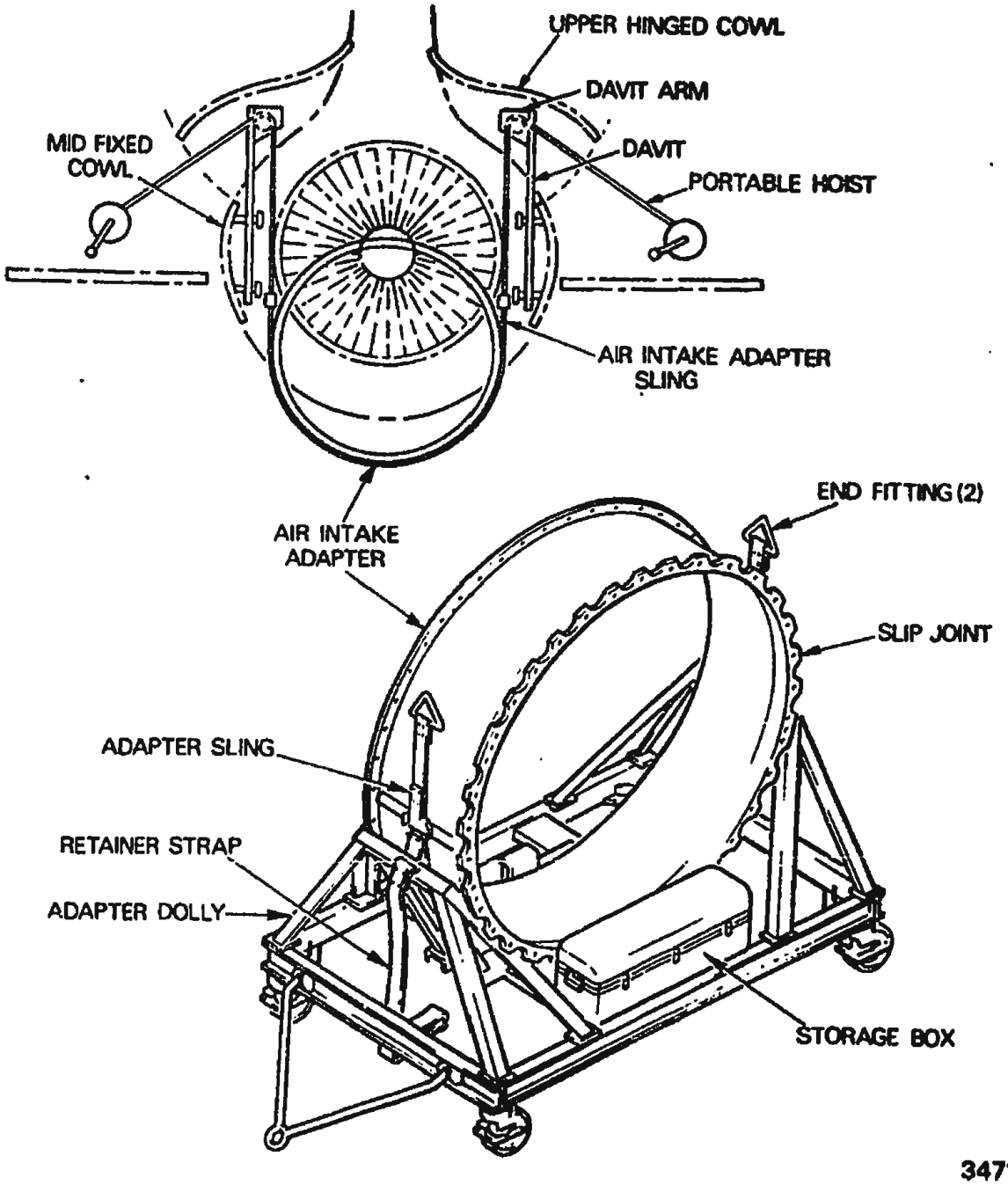
(15) Take weight of intake adapter on hoists, positioning davit arms and hoists for a vertical load.

(16) Remove bolts and washers securing adapter to L.P. compressor case front flange.

(17) Remove bolts and washers securing adapter to S-duct.

NOTE: It may be necessary to lower the air intake adapter slightly to relieve S-duct load for removal of bolts.

(18) Compress adapter slip joint, fig.408 (Sheet 2 and 3) and lower adapter carefully ensuring clearance between adapter and all attaching parts.

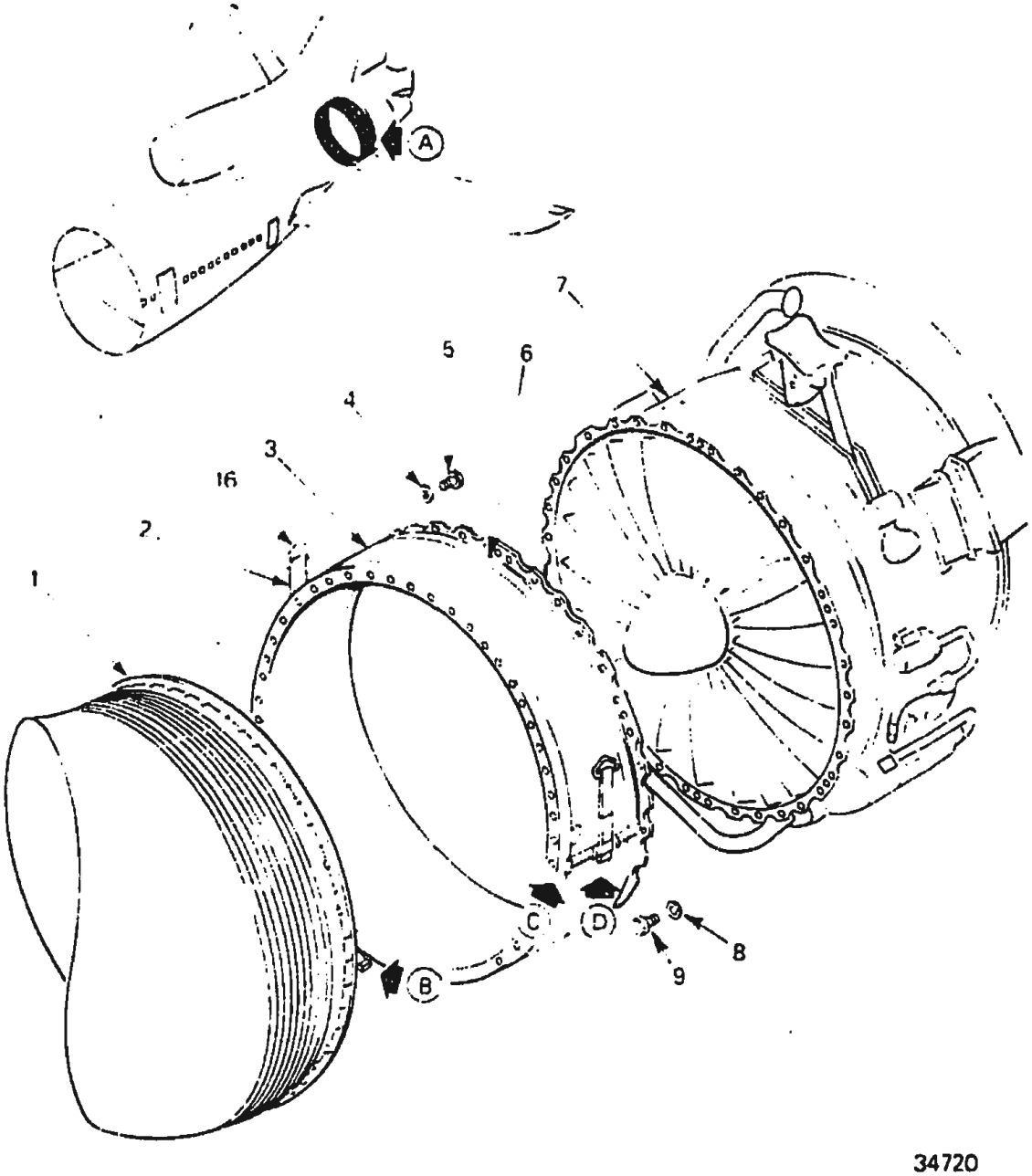



R Remove/Install air intake adapter
R Fig.408 (Sheet 1)

R EFFECTIVITY: Engine 2

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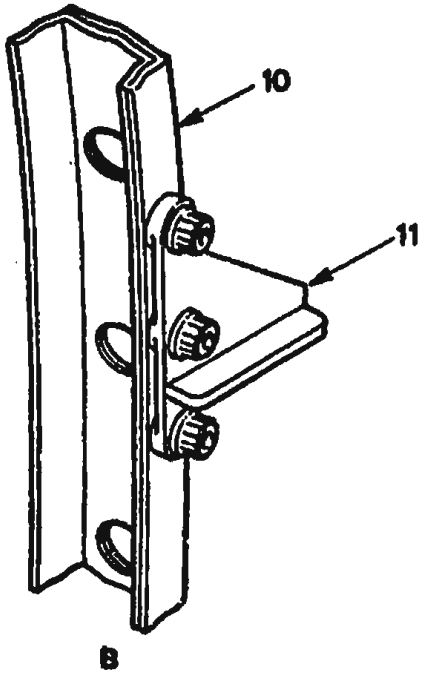

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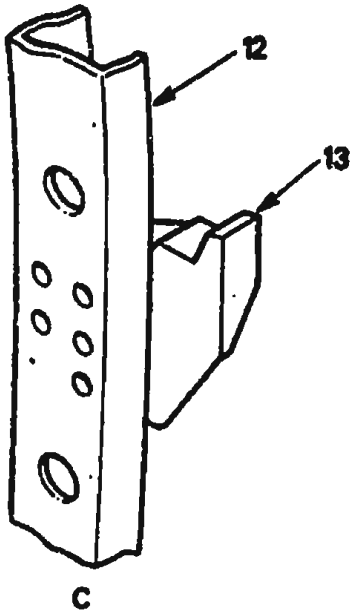
R Remove/Install air intake adapter
R Fig.408 (Sheet 2)

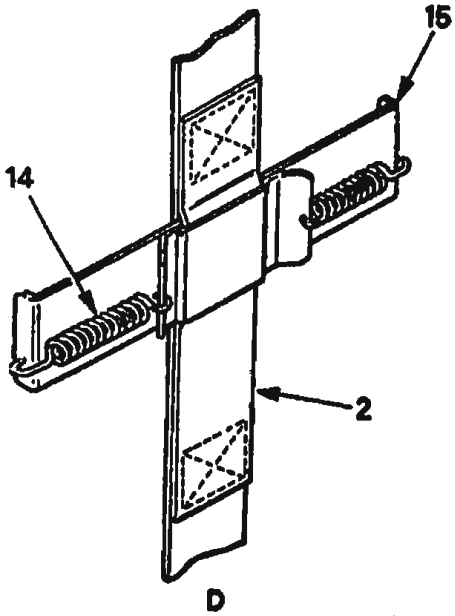
R EFFECTIVITY: Engine 2

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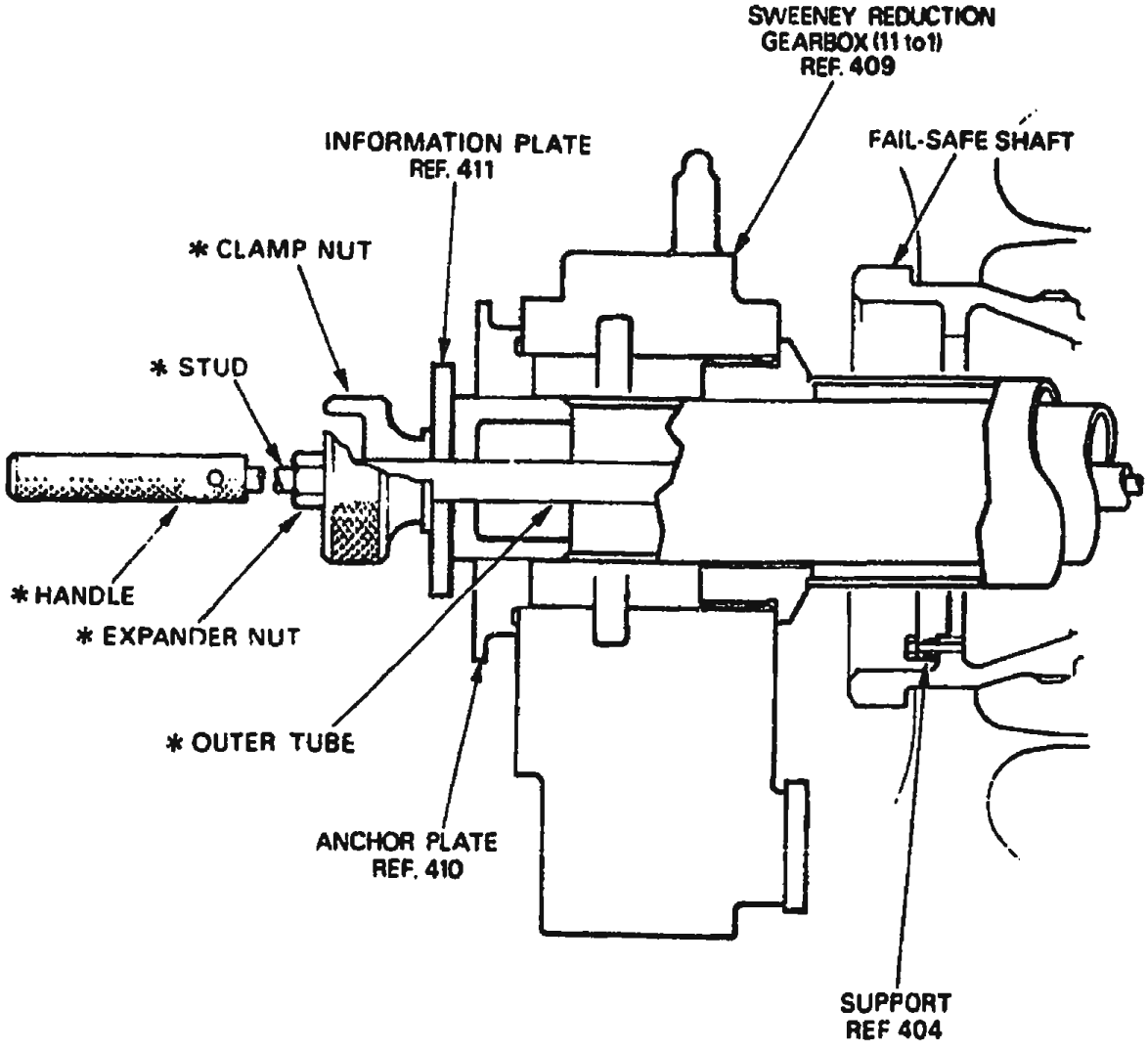

1. S-duct
2. Air intake adapter sling, ref. 419
3. Air intake adapter
4. Washer (32 places)
5. Bolt (32 places)
6. Slip joint
7. QEC unit
8. Washer (36 places)
9. Bolt (36 places)
10. S-duct flange
11. Alignment fitting
12. Adapter flange
13. Alignment fitting
14. Spring (2 places)
15. Restrainer (2 places)
16. End fitting (2 places)

58628

R Remove/Install air intake adapter
R Fig.408 (Sheet 3)

R EFFECTIVITY: Engine 2
R
R
050B

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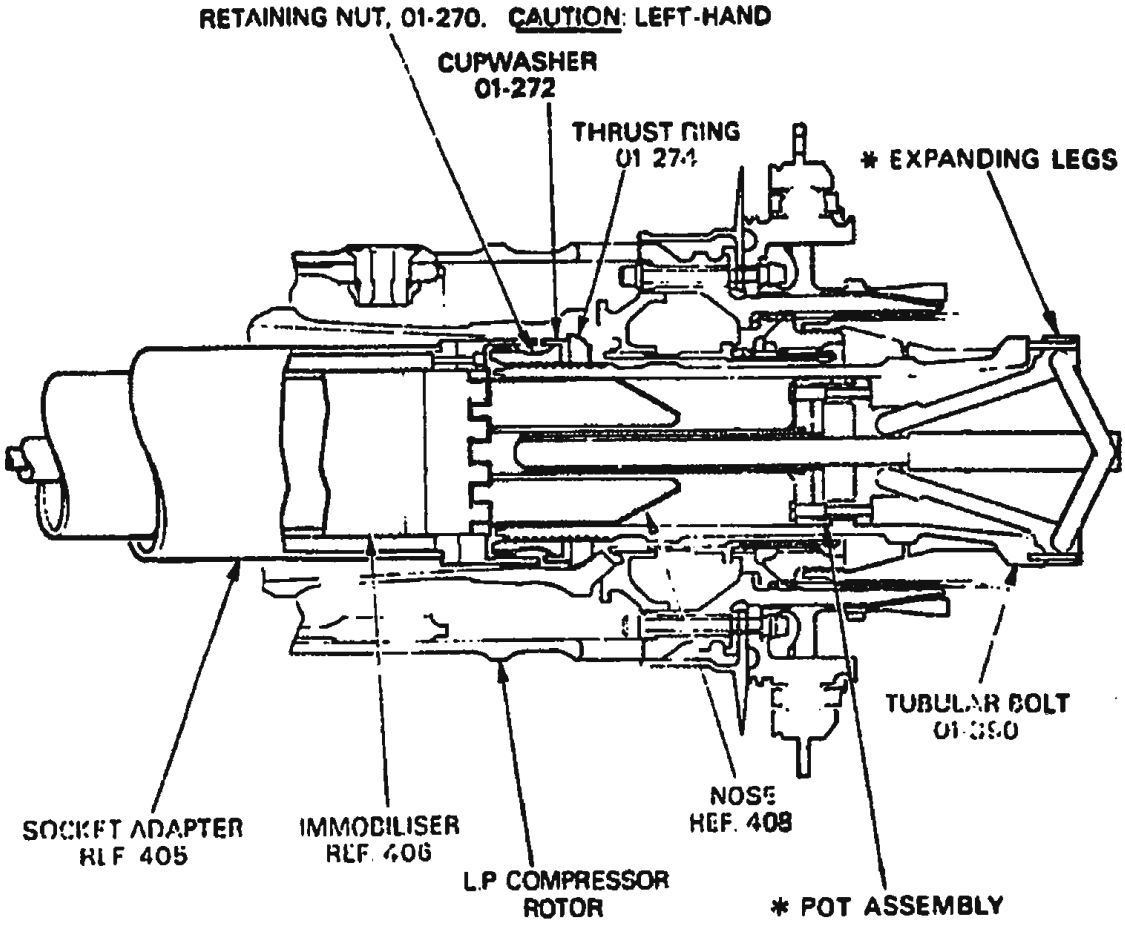

*Details of retaining tool, REF 407

34246

R Remove/Install L.P. shaft retaining bolt nut
R Fig.409 (Sheet 1)

R EFFECTIVITY: Engine 2

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R
050B 1T



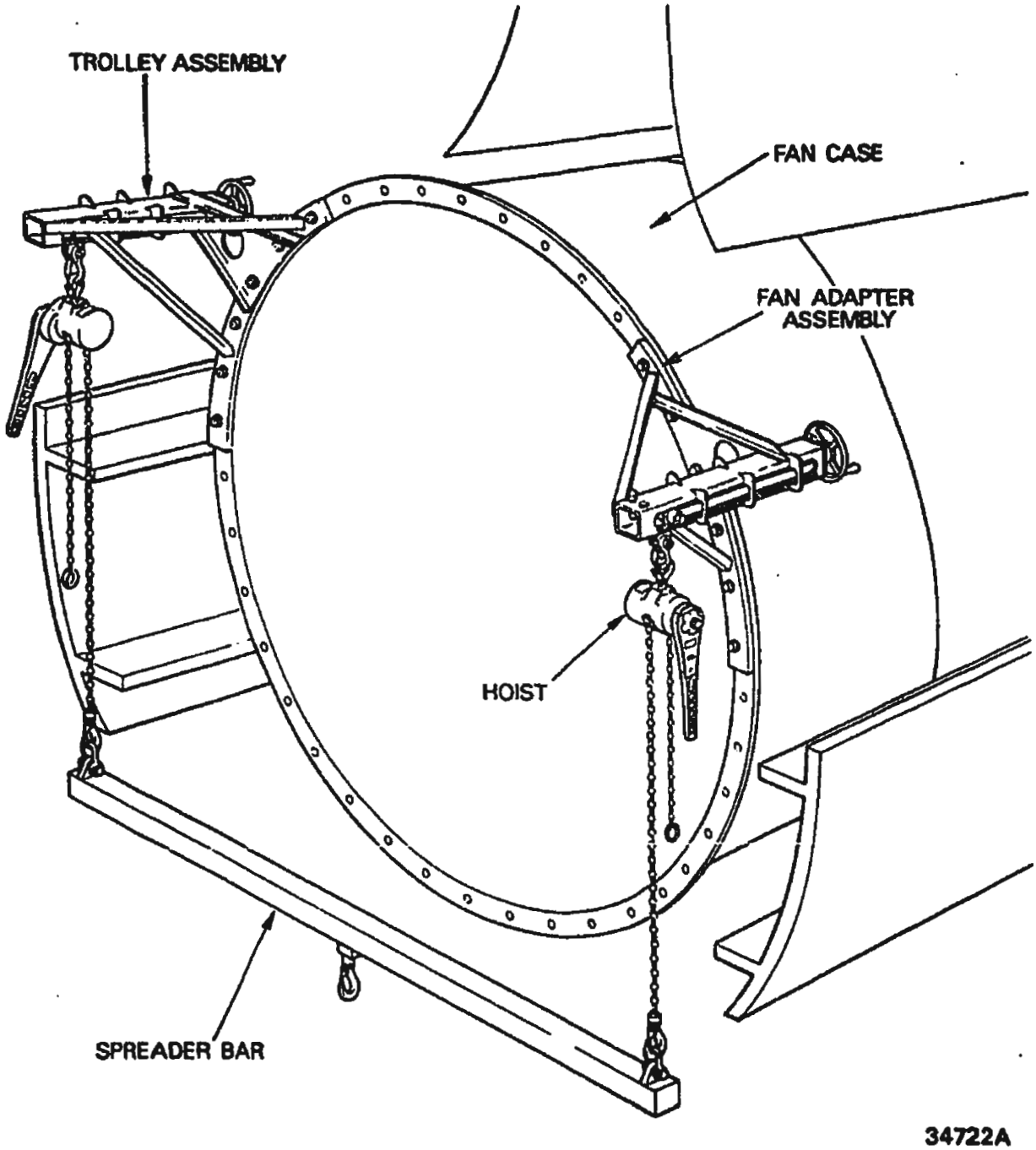

* Details of retaining tool, REF.407

34247

R Remove/Install L.P. shaft retaining bolt nut
R Fig.409 (Sheet 2)

R EFFECTIVITY: Engine 2

R
R
050B 1T




R Fit/remove adapter assemblies
R Fig.410

R EFFECTIVITY: Engine 2

(19) Place and secure adapter in adapter dolly, fig.408 (Sheet 1).

(20) Remove hoists and sling from adapter.

(21) Remove portable hoists and davit assemblies from mid fixed cowls.

4. Remove L.P. compressor disc and blades

A. Remove L.P. compressor fail-safe shaft.

(1) Fit tubular bolt retaining tool, HU.21395/1, fig.409 (Sheet 1 and 2).

(a) Remove clamp nut from outer tube of retaining tool.

(b) Unscrew expander screw and collapse expanding legs.

(c) Insert retaining tool through bore of fail-safe shaft and locate pot assembly in bore of tubular bolt.

(d) Continue pushing tool rearward until red alignment mark on outer tube is rearward of forward face of fail-safe shaft.

(e) Hold outer tube and pull handle forward to open expanding legs.

(f) Run down expander nut but do not tighten at this stage.

(g) Grip outer tube and pull tool forward until expanding legs contact rear face of tubular bolt; the red alignment mark on the outer tube should be in line with forward face of fail-safe shaft when tool is positioned correctly.

(h) Fully tighten expander nut.

(2) Remove L.P. compressor shaft retaining nut, fig.409 (Sheet 1 and 2).

(a) Fit support, HU.20055 or HU.26569, to front flange of fail-safe shaft.

(b) Fit socket adapter, HU.19564/1, through bore of fail-safe shaft to locate in retaining nut castellations.

(c) Screw nose, HU.21402, into rear end of immobiliser, HU.19565/3.

(d) Enter immobiliser through bore of socket adapter to locate in bore of tubular bolt and engage dogs at forward end of bolt.

(e) Fit reduction gearbox, 1704300 or 1012394, to socket adapter.

(f) Fit anchor plate, HU.12763, to reduction gearbox.

(g) Fit information plate, HU.21403, to outer tube of retaining tool.

(h) Fit and tighten clamp nut on outer tube of retaining tool.

CAUTION: L.P. SHAFT RETAINING BOLT NUT IS LEFT-HAND THREAD.

(j) Release L.P. shaft retaining bolt nut and turn nut clear of bolt.

(k) Remove clamp nut, information plate, anchor plate and reduction gearbox.

(l) Remove immobiliser, socket adapter and support.

(m) Remove retaining bolt, nut, cupwasher and thrust ring.

R NOTE: The cupwasher must be discarded.

CAUTION: DO NOT RELEASE OR ATTEMPT TO REMOVE TUBULAR BOLT RETAINING TOOL.

(3) Attach fan adapter assemblies to engine fan case, fig.410.

(a) Count down five bolt holes from top centre of fan case front flange; this hole is first attachment hole of adapter assembly.

(b) Position adapter assembly to fan case flange; fit and tighten bolts to secure and ensure that lower bolt hole on adapter aligns with first bolt hole below fan case horizontal centre line.

(c) Repeat operations (3) (a) and (b) for opposite adapter assembly.

(4) Screw pilot bar, HU.21410, on to tubular bolt using handle, Ref.414 fig.411 (Sheet 1).

(5) Unscrew retaining tool expander nut, fig.411 (Sheet 1), to release tension on expanding legs.

(6) Push retaining tool rearward until it does not protrude forward of fan disc.

(7) Lower fan adapter assembly hoists and secure to spreader bar, fig.410.

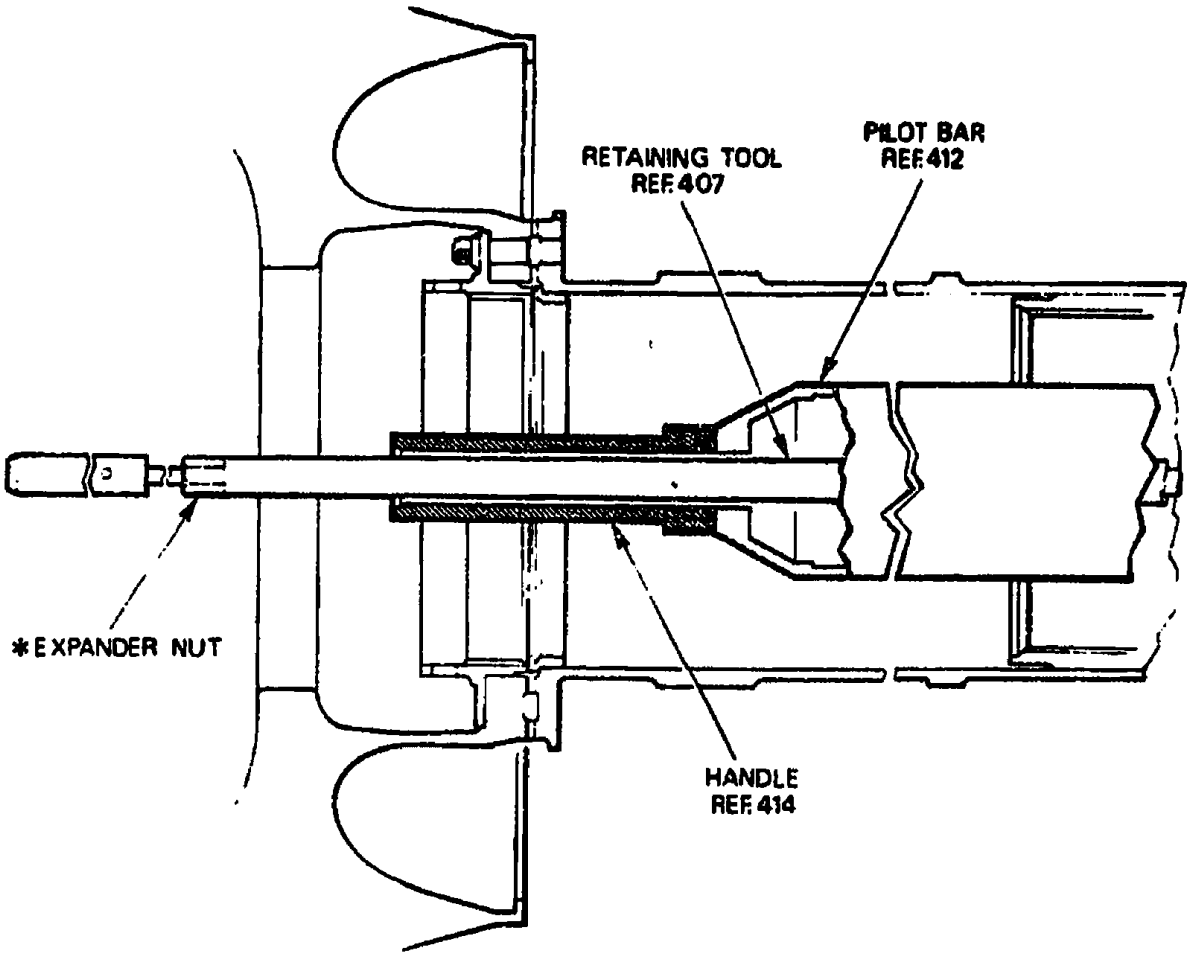
(8) Raise hoists to lift spreader bar.

R (9) Fit installation cradle, HU.21675/2; secure with clamps to rotor disc and secure sliding support and handle,
R HU.26966 to flange of fail-safe shaft, fig.412 (Sheet 1).

(10) Pull handle to withdraw fail-safe shaft forward along installation cradle.

(11) Fit protection sleeve, XUT.42395, to bore of L.P. compressor rotor disc, fig.412 (Sheet 2).

(12) Fit and secure lifter, XUT.38280, to fail-safe shaft, fig.412 (Sheet 1).

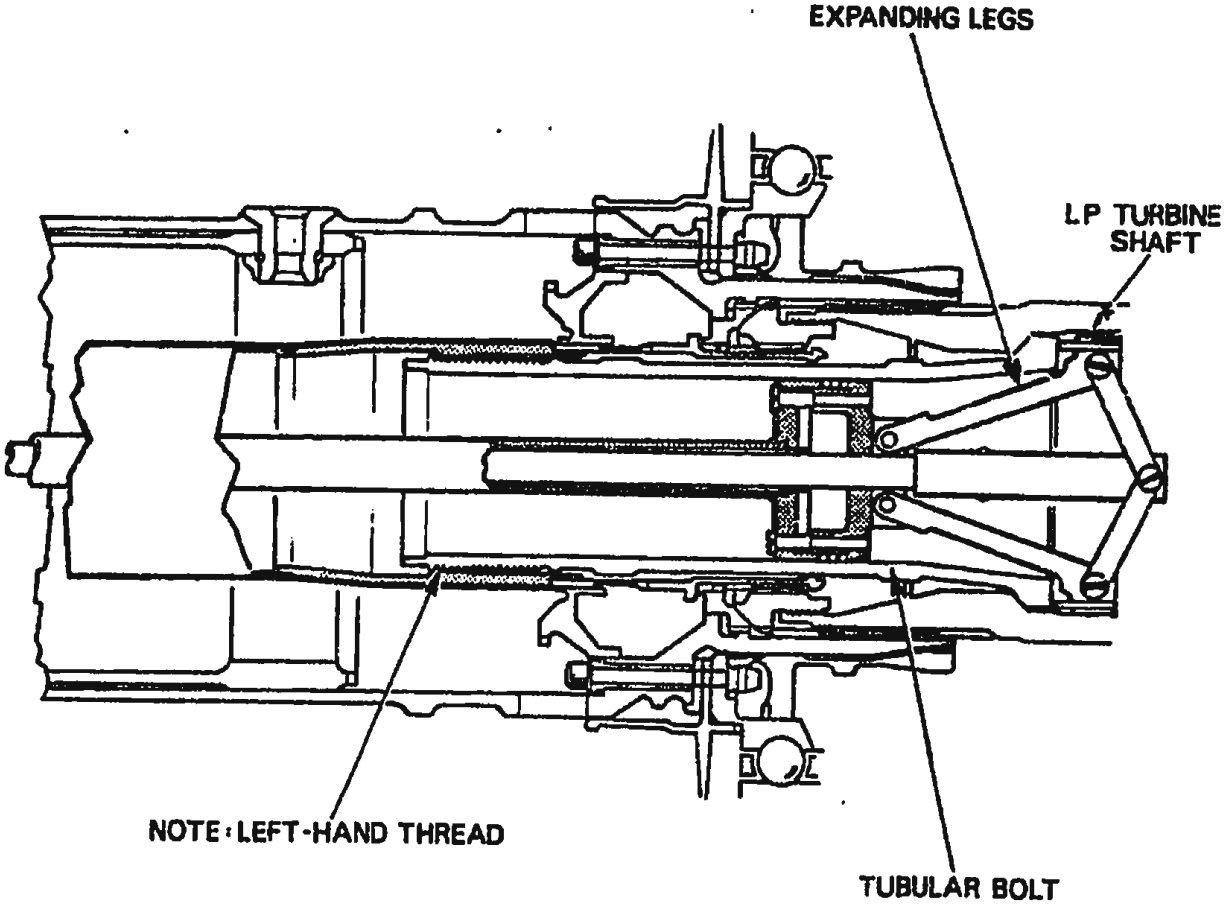



*Details of Ref 407

34248

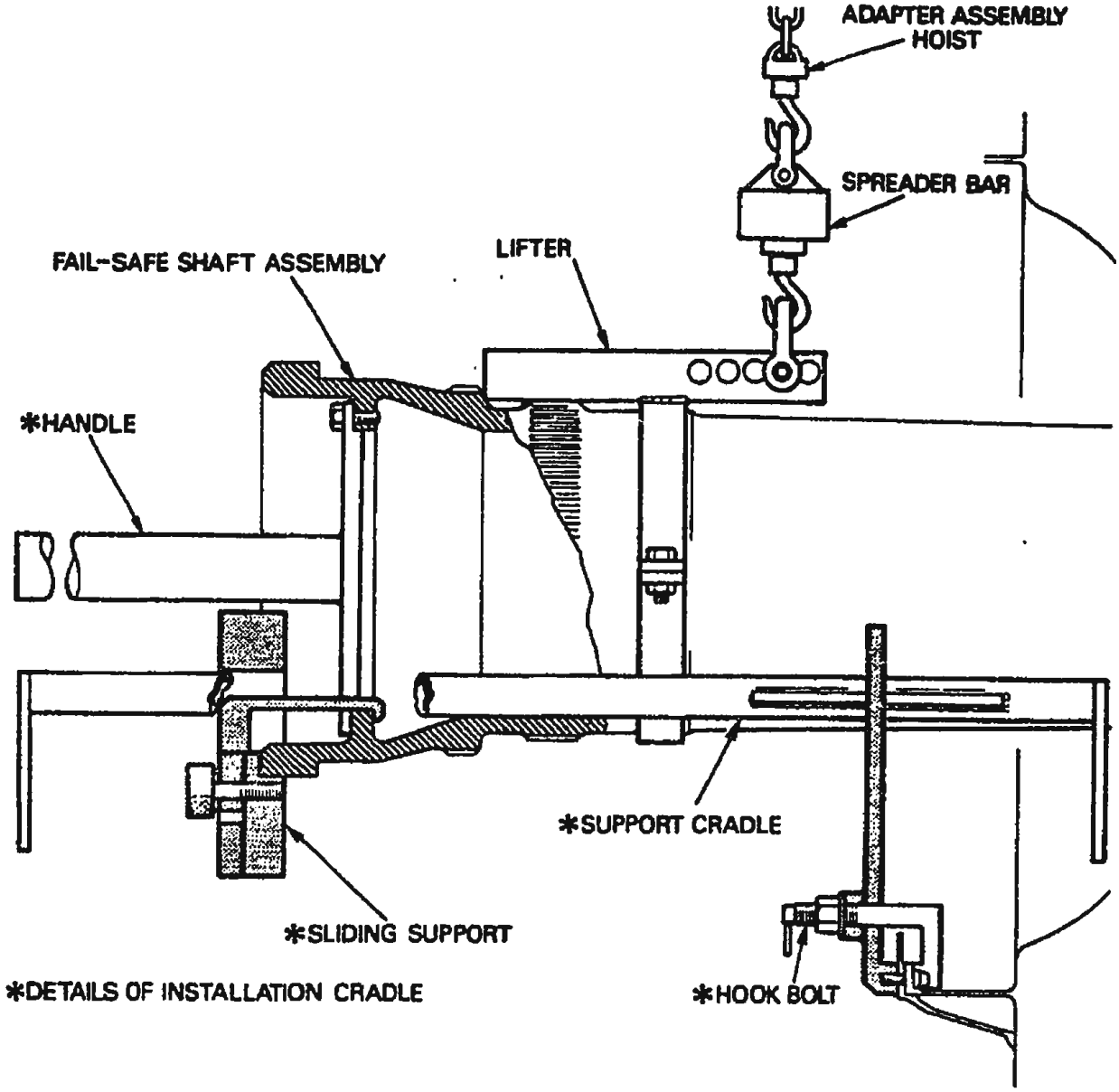
R Fit pilot bar to tubular bolt
R Fig.411 (Sheet 1)

R EFFECTIVITY: Engine 2
R
R
050B 1T

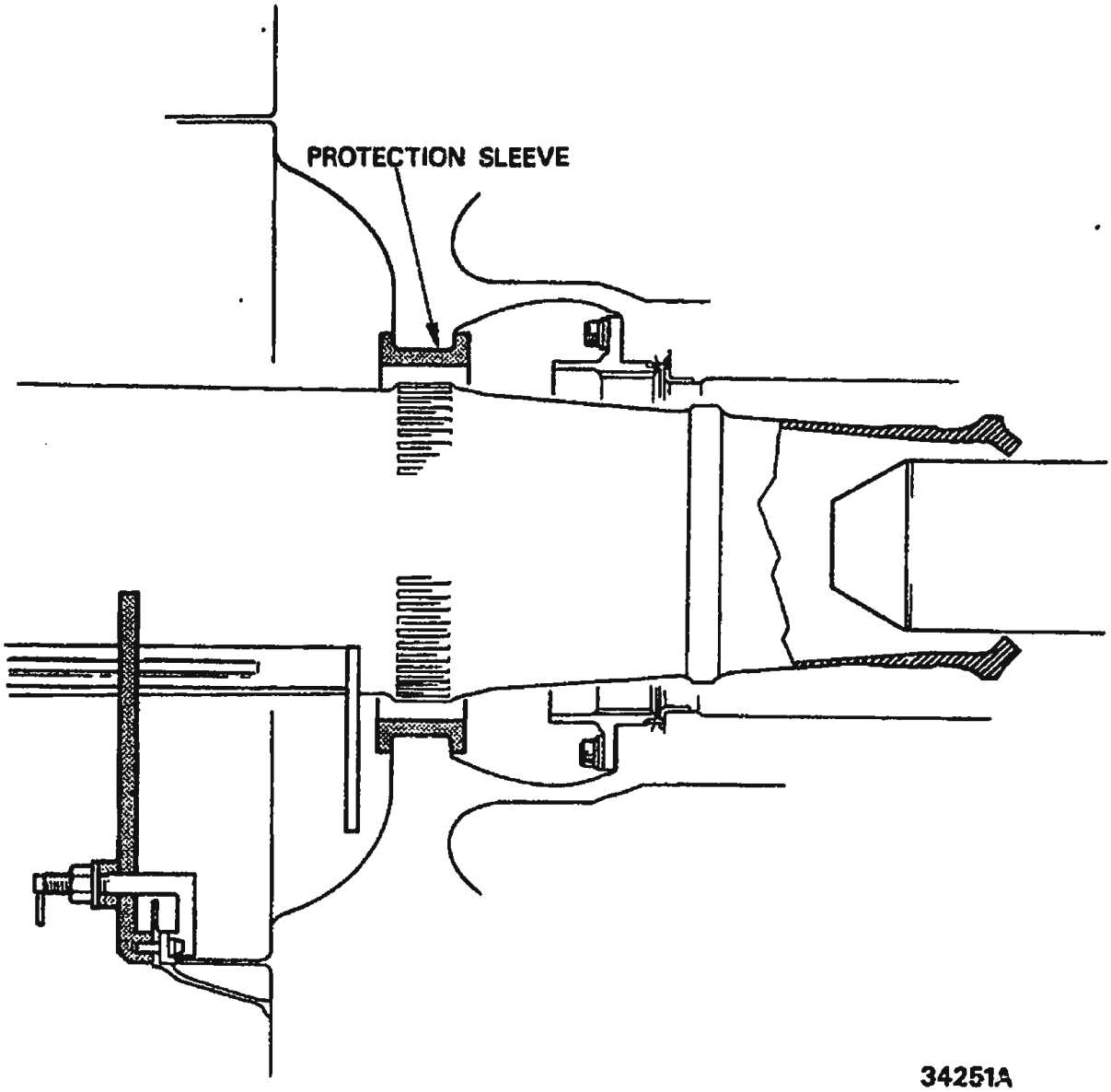



R
R Fit pilot bar to tubular bolt
Fig.411 (Sheet 2)

R
R
R
R EFFECTIVITY: Engine 2

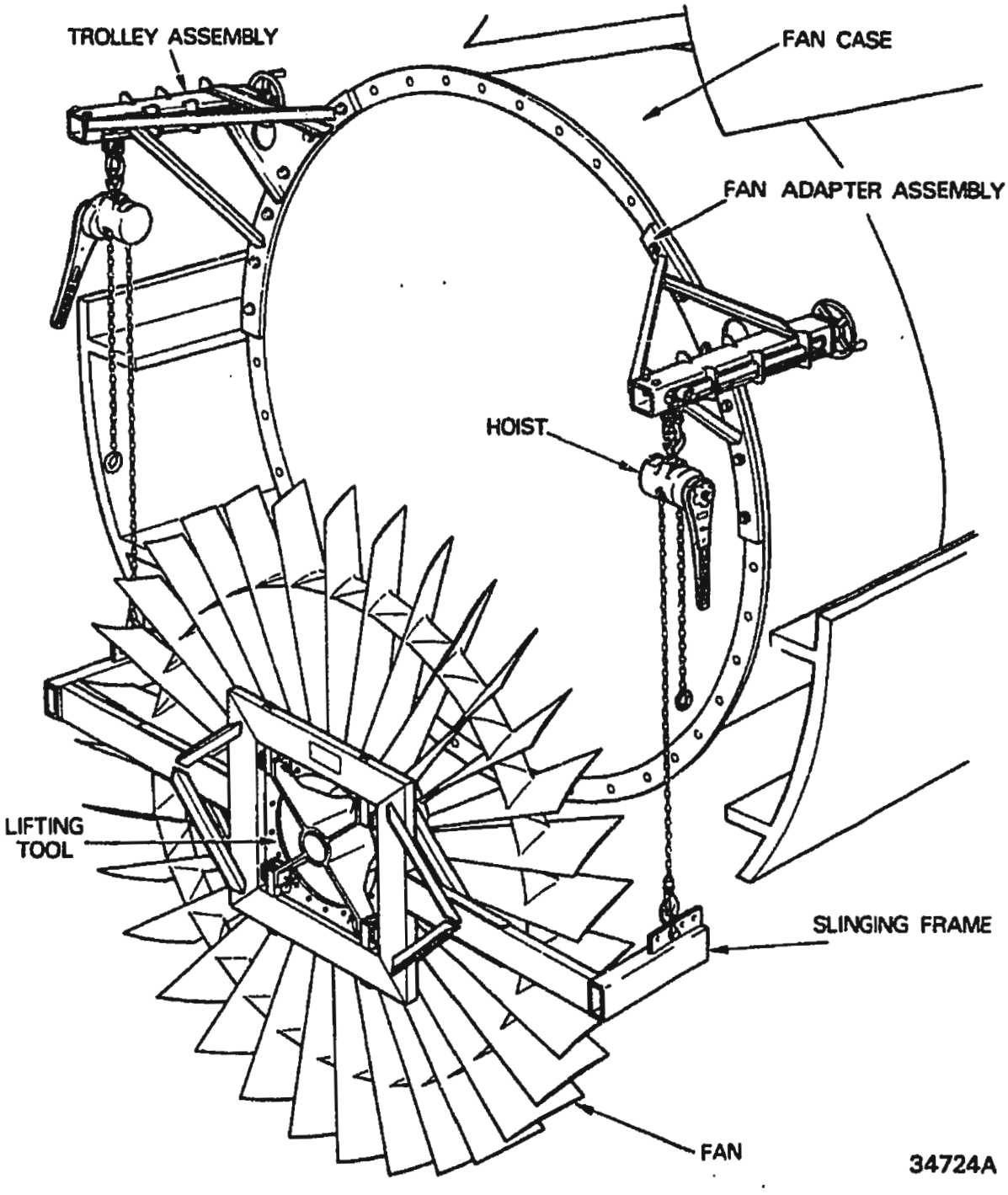



R Remove/Install fail-safe shaft
R Fig.412 (Sheet 1)

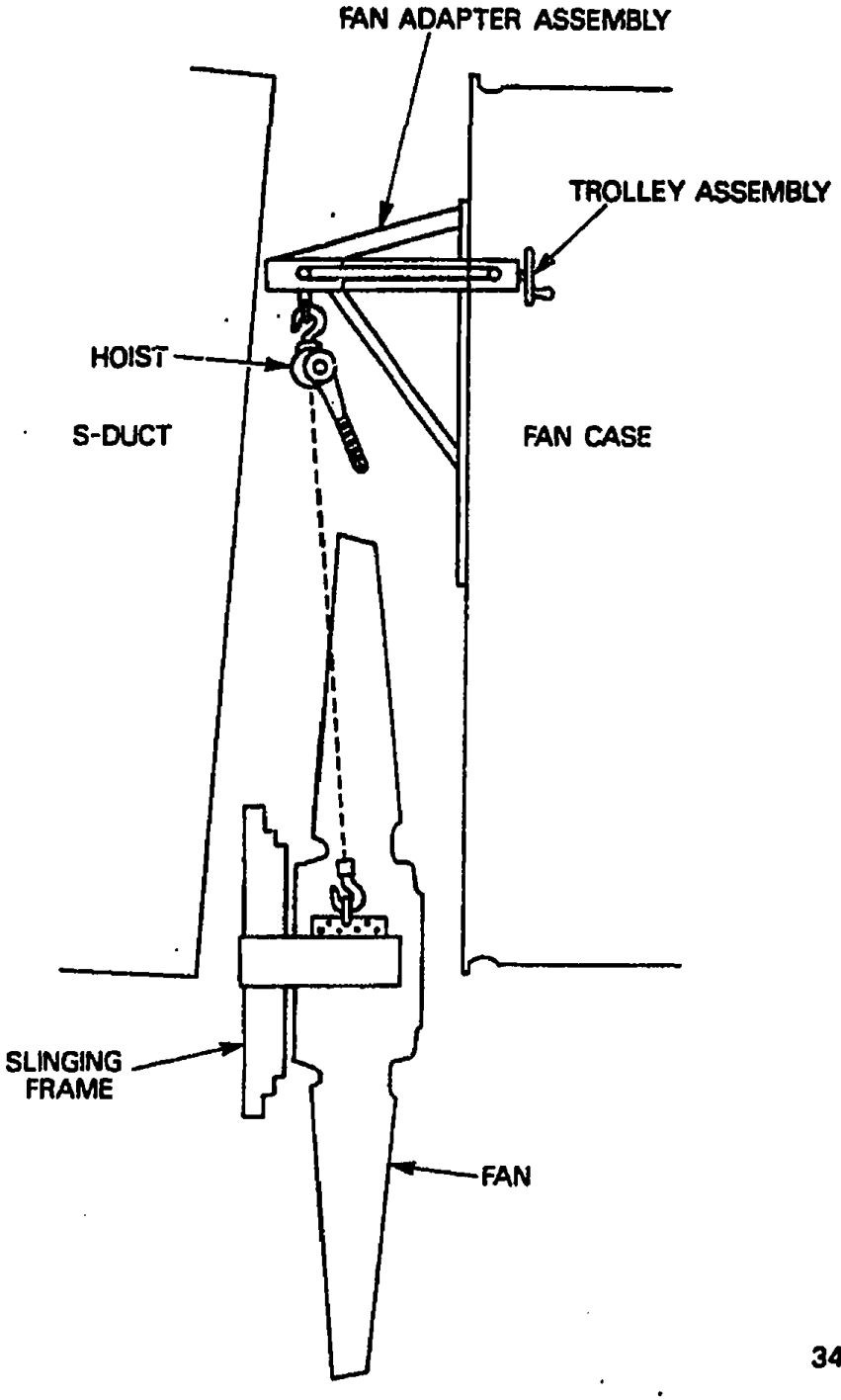



R Remove/Install fail-safe shaft
R Fig.412 (Sheet 2)

R EFFECTIVITY: Engine 2
R
R
050B 1T




R L.P. compressor disc and blades removal/installation
R tool set-up
R Fig.413 (Sheet 1)




R L.P. compressor disc and blades removal/installation tool set-up
R Fig.413 (Sheet 2)
R

(13) Lower spreader bar, fig.410, and secure to fail-safe shaft lifter.

(14) Take weight of fail-safe shaft on hoists.

(15) Release hook bolts securing fail-safe shaft installation cradle to L.P. compressor disc, fig.412.

(16) Traverse hoists forward until fail-safe shaft is clear of L.P. compressor disc.

(17) Turn fail-safe shaft through 90 degrees and lower shaft between S-duct and fan case flange.

(18) Lower shaft to padded pallet and disconnect spreader bar.

(19) Remove pallet and shaft from working area.

(20) Remove spreader bar from hoists.

J. Withdraw L.P. compressor disc and blades.

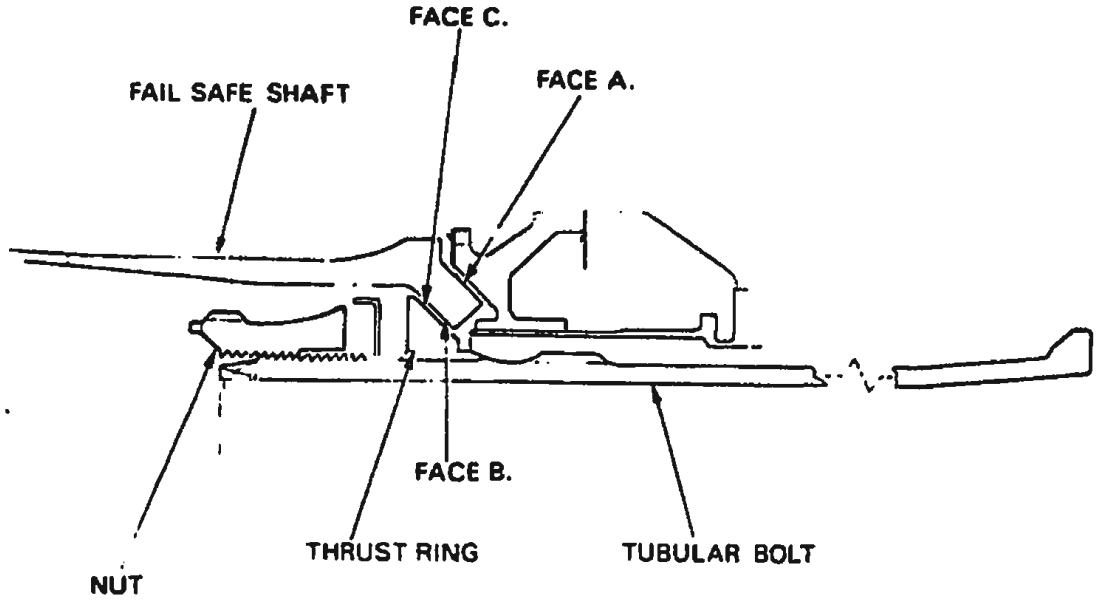
(1) Position slinging frame, 1305269-101, fitted with lifting tool, HU.20133/3, and ring, HU.21490, beneath air intake adapter aperture.

(2) Secure adapter assembly hoists to slinging frame at centre of gravity of frame.

(3) Hoist slinging frame to position on L.P. compressor disc, fig.413 (Sheet 1).

(4) Position working platform, BG.33, between S-duct and L.P. compressor case.

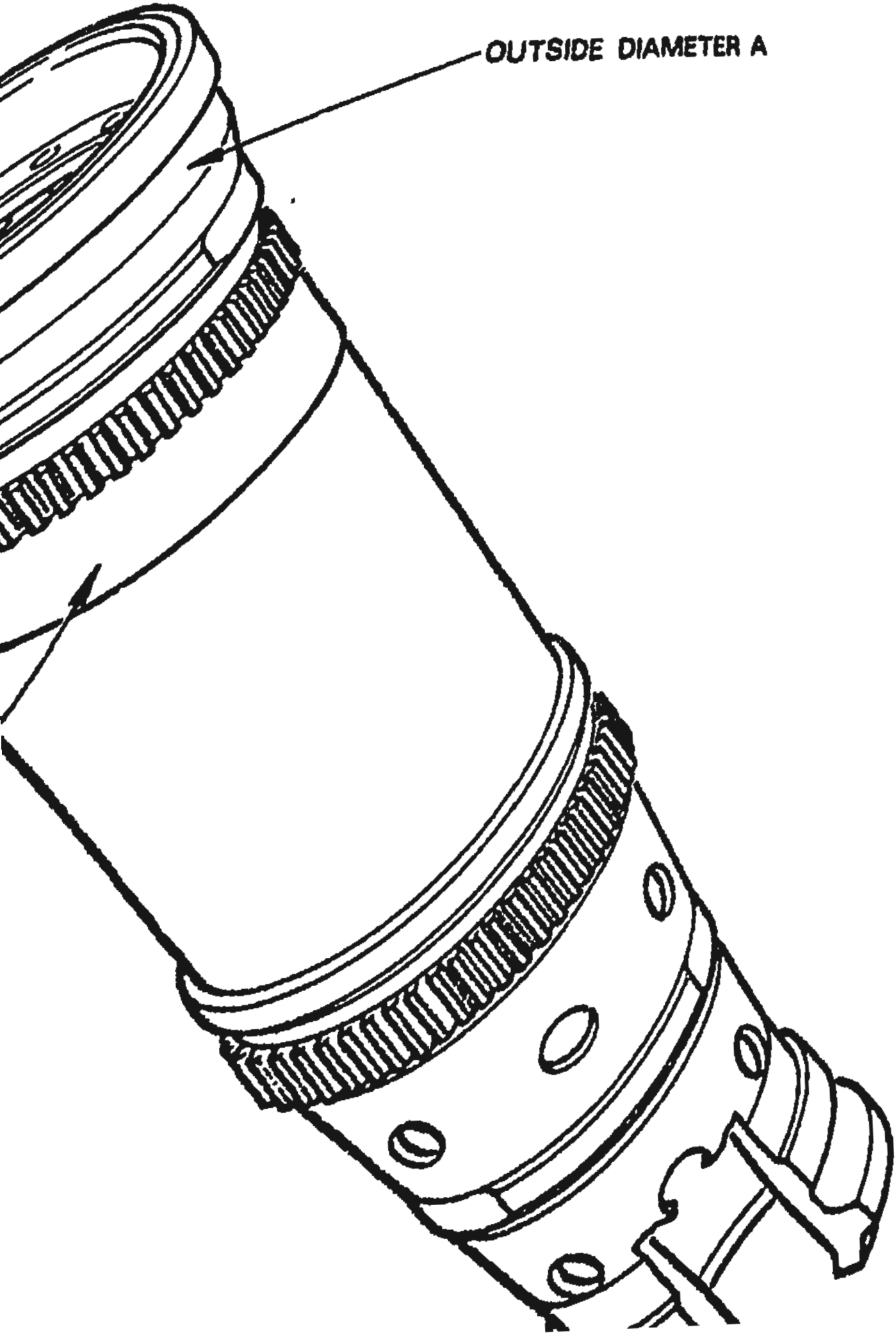
(5) Align bolt holes in lifting tool with compressor disc flange nuts; fit and tighten lifting tool bolts to secure lifting tool to disc.




34252

R Inspection areas on fail safe shaft, thrust ring
R tubular bolt and nut
R Fig.414 (Sheet 1)

R EFFECTIVITY: Engine 2


OUTSIDE DIAMETER A

(6) Transfer hoists to centre of gravity position for combined disc and tooling; take weight of compressor disc on hoists.

(7) Place protective workmat in L.P. compressor case between compressor blades and case.

(8) Release and remove all disc/shaft curvic coupling bolts using spanner, HU.20704/3.

(9) Remove working platform from work area.

(10) Traverse disc clear of compressor case; operate both trolley assembly handles simultaneously.

CAUTION: TO PREVENT DAMAGE TO COMPRESSOR DISC AND/OR SURROUNDING STRUCTURE, PROGRESSIVELY ALTER LATERAL POSITION OF HOISTS TO MAINTAIN CLEARANCE BETWEEN S-DUCT, DISC AND COMPRESSOR CASE, FIG.413 (SHEET 2).

(11) Lower disc through air intake adapter aperture.

(12) When disc is clear of air frame, rotate disc to horizontal position (slinging frame uppermost) and lower onto a padded pallet.

(13) Release lifting tool to disc securing bolts and hoist slinging frame and lifting tool clear of disc.

(14) Remove disc and pallet from working area.

5. Inspect the L.P. compressor disc and blades interfaces

A. Inspect the rear face of disc and blades

(1) Visually inspect interface for general condition, damage to seals, security of all bolts, washers, nuts, etc.

(2) Inspect curvic coupling teeth for cracks, galling and impact damage

| | | |
|---|---|---|
| (a) | Cracked | Reject |
| (b) | Galled or damaged | Repair, FRS.3253 (70-42-11) |

(3) Inspect fail-safe shaft outside diameters (fig.4, Sheet 2)

NOTE: The galling/scored limits quoted are the total depth of material loss allowed in retain to the unworn area of the shaft, irrespective of the number of times FRS.3253 has been applied.

(a) Galling - Outside diameter A

| | | |
|---|---|---|
| (i) | Up to a depth of 0.003in. (0,08 mm.) | Repair, FRS.3253 (70-42-11) |
| (ii) | In excess of (i) | Reject |

(b) Scored - Outside diameter A

| | | |
|---|---|---|
| (i) | Up to depth of 0.003in. (0,08 mm.) | Repair, FRS.3253 (70-42-11) |
| (ii) | In excess of (i) | Reject |

(c) Galling - Outside diameter B

| | | |
|---|---|---|
| (i) | Up to a depth of 0.002in. (0,05 mm.) | Accept |
| (ii) | In excess of (i) | Repair, FRS.3253 (70-42-11) |

(4) Inspect fail-safe shaft spherical inner and outer surface (fig.414, Sheet 2) and thrust ring face (fig.414, Sheet 1)

NOTE: The galling limits quoted for the spherical diameter are the total depth of material loss allowed in relation to the unworn area of the spherical surfaces irrespective of the number of times FRS.3253 is applied. If the wear pattern is such as to preclude assessment of the depth, the shaft should be rejected.

(a) Galling

| | |
|---|---|
| (i) Galling to a depth of 0.003in. (0,076 mm.) provided not more than 30% of the contact area is affected | Repair, FRS.3253 (70-42-11) |
| (ii) Galling in excess of the above | Reject |

(5) Inspect threads and load face of nut for pick-up

| | |
|---|---|
| (a) Pick-up threads and/or load faces | Repair, FRS.3253 (70-42-11) |

(6) Inspect I.P. compressor rotor disc curvic coupling teeth for cracks, galling and impact damage

| | |
|---|---|
| (a) Cracked | Reject |
| (b) Galled or damaged | Stone/hand polish 70-42-11, FRS.3253 |

(7) Inspect L.P. compressor rotor split driving ring assembly.

(a) Inspect the splines for cracks and galling

| | | |
|---|---|---|
| (i) | Cracked | Reject |
| (ii) | Galled | Stone/hand polish 70-42-11, FRS.3253 |

(b) Inspect the front face for galling around the bolt holes

| | | |
|---|---|---|
| (i) | Galled | Stone/hand polish 70-42-11, FRS.3253 |

(c) Inspect rear face of integral spacers for galling

| | | |
|---|---|---|
| (i) | Galled | Stone/hand polish 70-42-11, FRS.3253 |

(8) Visually inspect the rear stepped air seal for indications of rubbing

| | | |
|---|---|---|
| (a) | Light rubbing | Stone/hand polish 70-42-11, FRS.3253 |

B. Inspect the L.P. compressor rotor blade airfoils for damage (Ref. 72-31-05).

C. Inspect the front face of I.P. compressor

(1) Visually inspect interface for general condition, damage to seals, security of all bolts, nuts, etc.

(2) Visually inspect static bore of rear stepped air seal for indications of rubbing

| | | |
|---|---|---|
| (a) | Light rubbing | Accept |

(3) Inspect the I.P. compressor fixed inlet guide vanes for dents and cracks

| | | |
|---|---|---|
| (a) | Dented and/or punctured, provided no secondary cracks | Accept |

R (b) A crack in the airfoil which does not extend into an area 0.250in. (6.35 mm) from the leading or trailing edges — Accept

(4) Inspect the service tubes for dents and cracks

(a) Dented provided no sharp edges or bottoms exist — Accept

(b) Cracked — Reject

(5) Check that metal seal ring is free to move in L.P. bearing inner race seal ring groove.

(6) Check that fail safe shaft support bush, is fitted to bore of L.P. compressor rotor shaft.

(7) Inspect L.P. compressor rotor shaft curvic coupling teeth for cracks, galling and impact damage.

(a) Cracked — Reject

(b) Galled or damaged — Stone/hand polish 70-42-11, FRS.3253

D. Inspect the L.P. compressor case and vanes (Ref. 72-31-01)

6. Install L.P. compressor disc and blades

A. Materials required

| Material | British Spec. | American Spec. | OMat Item |
|---|---|---|---|
| Dry film lubricant (PL.94) | PJP4862X 6990 | - | 4/44A |
| Felt tip marker | - | - | 262 |
| Clean engine oil | - | - | 1011 |

B. Inspect mini-module interfaces /2 at split line as detailed in paragraph 5.

C. Correlate compressor disc and shaft.

CAUTION: IT IS NECESSARY TO POSITION CORRELATION MARKS AS INSTRUCTED TO ENABLE THE MASTER BOLT HOLES IN THE DISC TO ALIGN WITH SIMILAR HOLES.

(1) Compressor disc (fig.418) correlation

(a) Using felt tip marker, mark correlations on splines in bore of driving ring.

(2) Compressor shaft (fig.419) correlation

(a) Using felt tip marker, mark correlations on shaft bore adjacent to the curvic teeth.

D. Fit and secure L.P. compressor disc and blades

R CAUTION: PRIOR TO INSTALLATION OF REPLACEMENT L.P.
R COMPRESSOR DISC AND BLADES THE TRIM BALANCE
R WEIGHTS (IF FITTED) MUST BE REMOVED.

(1) Position replacement disc, mounted on padded pallet, beneath air intake adapter aperture.

(2) Fit protection sleeve, XUT.42395, fig.412 to bore of compressor disc.

(3) Connect adapter assembly hoists to slinging frame, fitted with lifting tool, HU.20133/3, and ring, HU.21490, and position frame and lifting tool on replacement disc.

(4) Fit and tighten lifting tool bolts to secure tool to disc.

(5) Transfer hoists to centre of gravity position for combined tooling and disc.

(6) Hoist disc assembly clear of pallet and rotate to vertical position.

(7) Operate trolley assembly handles to position disc centrally below air intake adapter aperture, fig.413 (Sheet 2)

CAUTION: TO PREVENT DAMAGE TO COMPRESSOR DISC AND/OR SURROUNDING STRUCTURE, PROGRESSIVELY ALTER LATERAL POSITION OF HOISTS TO MAINTAIN CLEARANCE BETWEEN S-DUCT, DISC AND COMPRESSOR CASE, FIG.413 (SHEET 2).

(8) Hoist disc through air intake adapter aperture.

(9) Traverse disc assembly rearward, aligning correlation marks until two halves of coupling are in engagement; operate both trolley assembly handles simultaneously.

(10) Position working platform, BG.33, in air intake adapter aperture.

(11) R Measure shank of curvic coupling bolts, if length exceeds 2.895in. (73,533 mm.) reject bolts.

(12) Check curvic coupling for full engagment as follows:

(a) Using adjusting wrench (HU29179) locate special (plastic) bolt (HU29175) on wrench. Ensure square drive is locked.

(b) Install special bolts (Qty 3 - off) in curvic coupling bolt holes at equi-distant positions engage threads and screw bolts fully home.

NOTE: If special bolts will not engage threads, traverse disc forward to clear coupling, slightly rotate shaft and repeat checks until special bolts can be satisfactorily fitted.

(13) Apply clean engine oil to threads and mating faces of curvic coupling securing bolts.

CAUTION: S.B.72-3132 INTRODUCES BOLTS OF IDENTICAL LENGTH TO SECURE BOTH PRE S.B.72-2958 AND S.B.72-2958 STANDARD COMPRESSOR DISCS. BOLTS INSTRUCTED BY S.B.72-2958 MUST NOT BE USED.

(14) Engage and run down curvic coupling bolts (32 - off) using run down spanner, to light contact using the procedure and sequence defined in 70-51-00. Remove special bolts.

(15) Engage and run down remaining curvic coupling securing bolts (3 - off) as detailed in Item (14).

(16) Adjust hoists to centre of gravity of combined slinging frame and lifting tool and remove.

(17) Using a mirror and lighting equipment check alignment of correlation on disc and compressor shaft.

(18) Spin rotor and re-check that all bolts are in light contact. If not, re-tighten as necessary.

(19) Reposition combined slinging frame and lifting tool secure to L.P. compressor disc and blades.

(20) Adjust hoists to centre of gravity of slinging frame (1305269-101) disconnect from lifting and traverse clear and lower.

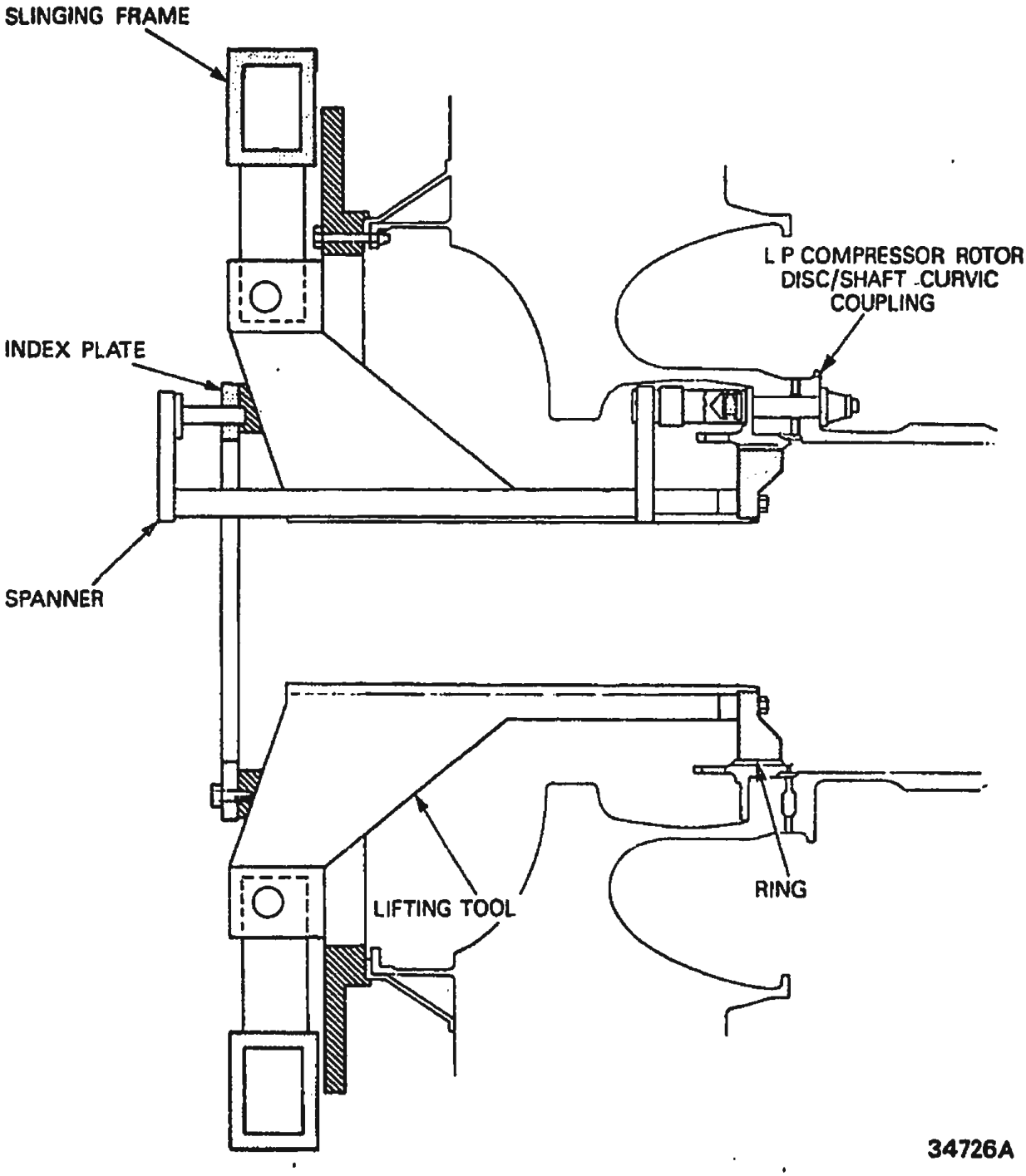
(21) Fit and secure index plate, HU.21468, to bosses on forward face of lifting tool, fig.415, ensuring hole marked No.1 on index plate is at 9 o'clock position.

(22) Insert spanner, HU.21398/1, through bore of compressor disc and locate peg of spanner in hole No.1 in index plate, fig.415.

(23) Tighten the curvic bolts by stages using sequence detailed in 70-51-00.

CAUTION: ALWAYS TIGHTEN BOLTS ON HORIZONTAL CENTRE LINE FIRST WHEN ASSEMBLING THE ENGINE HORIZONTALLY. WHEN THE FINAL TORQUE LOAD IS BEING APPLIED, IT IS ESSENTIAL THAT THE TORQUE READING ON THE SPANNER IS ALWAYS INCREASING. IF A CONSTANT OR DECREASING TORQUE IS OBSERVED, THE BOLT MUST BE REPLACED.

(a) Torque tighten bolts to initial value of 200 lb.in. (23 Nm). Spin the rotor and check that the torque value is still 200 lb.in. (23 Nm).




Torque tighten curvic coupling securing bolts
Fig.415

(b) Torque tighten to intermediate value of 400 lb.in. (45 Nm). Spin the rotor and check that the torque value is still 400 lb.in. (45 Nm).

(c) Torque tighten bolts to final value of 1015 lb.in. (114,7 Nm) and spin rotor.

(d) Starting at bolt/nut combination in hole 1 and proceeding in a clockwise direction, check each bolt/nut combination in turn to 1015 lb.in. (114,7 Nm).

(24) Remove spanner and index plate.

(25) Hoist slinging frame and reconnect to lifting tool.

(26) Transfer hoists to centre of gravity of combined slinging frame and lifting tool.

(27) Release and remove bolts securing lifting tool to disc.

(28) Remove working platform from air intake adapter aperture.

(29) Traverse slinging frame forward and clear of disc then lower to pallet or dolley; remove hoists.

(30) Remove slinging frame and lifting tool from working area.

E. Install L.P. compressor fail-safe shaft.

(1) Position fail-safe shaft fitted with lifter, XUT.38280, and installation cradle, HU.21675/2, below air intake adapter aperture.

(2) Apply dry film lubricant to load face at rear of fail-safe shaft.

(3) Secure spreader bar to adapter assembly hoists, fig.410.

(4) Attach spreader bar to fail-safe shaft lifter.

(5) Hoist fail-safe shaft through intake adapter aperture and into position in L.P. compressor disc.

(6) Locate and tighten hook bolts to secure cradle to L.P. compressor disc, fig.412 (Sheet 1).

(7) Disconnect spreader bar from fail-safe shaft lifter and hoist bar clear of working area.

(8) Remove protection sleeve from bore of compressor, fig.412 (Sheet 2).

(9) Remove fail-safe shaft lifter, fig.412 (Sheet 1).

(10) Push fail-safe shaft rearward along installation cradle and into location in L.P. compressor shaft.

(11) Remove fail-safe shaft installation cradle.

(12) Lower spreader bar and remove bar from hoists.

(13) Remove fan adapter assemblies from fan case flange, fig.410.

(14) Pull retaining tool forward until expanding legs abut rear of tubular bolt, fig.411 (Sheet 2).

NOTE: When tool is correctly positioned, red alignment mark on outer tube of tool will be in line with forward face of fail-safe shaft.

(15) Tighten retaining tool expander nut to expand legs into bore of L.P. turbine shaft, fig.411 (Sheet 1).

(16) Unscrew and remove pilot bar from tubular bolt using handle, HU.21396, fig.411 (Sheet 1).

NOTE: Tubular bolt has left-hand thread.

(17) Fit and tighten L.P. compressor shaft retaining nut.

R NOTE: A new cupwasher must be installed.

(a) Apply dry-film lubricant to load faces of cupwasher and thrust ring.

(b) Fit cupwasher and thrust ring to assembly tool, HU.21397, then fit to tubular bolt as detailed in fig.416.

(c) Fit support, HU.20055 or HU.26569, to forward flange of fail-safe shaft, fig.409 (Sheet 1).

(d) Fit nose, HU.21402, to immobiliser, HU.19565/3, fig.409 (Sheet 2).

(e) Enter immobiliser through bore of fail-safe shaft and locate in dogs on tubular bolt, fig.409 (Sheet 2).

(f) Apply dry film lubricant to threads of retaining nut.

(g) Locate nut to socket adapter, HU.19564/1.

(h) Guide socket adapter over assembled immobiliser to engage nut on threads of tubular bolt, fig.409 (Sheet 2); tubular bolt has left-hand thread.

(j) Fit reduction gearbox, 1704300 or 1012394, to socket adapter, fig.409 (Sheet 1)

(k) Fit anchor plate, HU.12763, to reduction gearbox, fig.409 (Sheet 1).

(m) Fit information plate, HU.21403, to outer tube of retaining tool, fig.409 (Sheet 1).

(n) Fit and tighten clamp nut on outer tube of retaining tool, fig.409 (Sheet 1).

(p) Torque tighten tubular bolt and retaining nut to 500 lb.ft. and temporarily mark the gearbox.

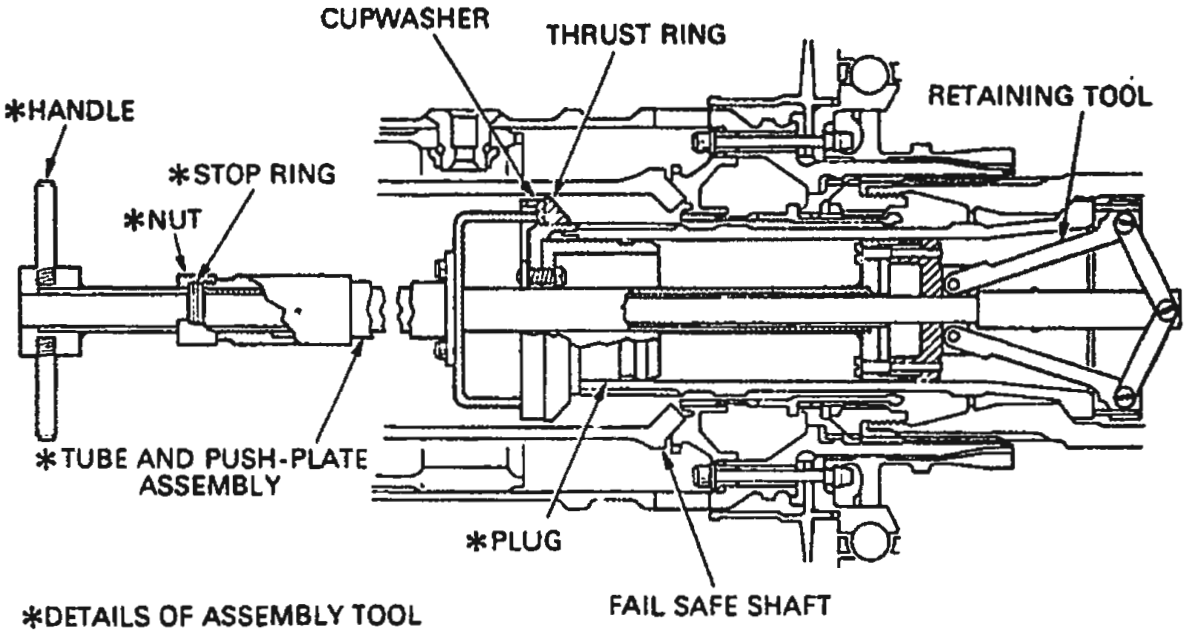
NOTE: Tubular bolt has a left-hand thread.

(q) Release retaining nut.

(r) Torque tighten retaining nut to 500 lb. ft. and ensure alignment of temporary marks on gearbox. If marks do not align, erase and repeat items (p), (q) and (r) until satisfactory alignment is achieved.

(s) Remove clamp nut, information plate, anchor plate and reduction gearbox also immobiliser, socket adapter and support.

(t) Unscrew expander nut to collapse retaining tool expanding legs then remove retaining tool; screw clamp nut on to retaining tool.

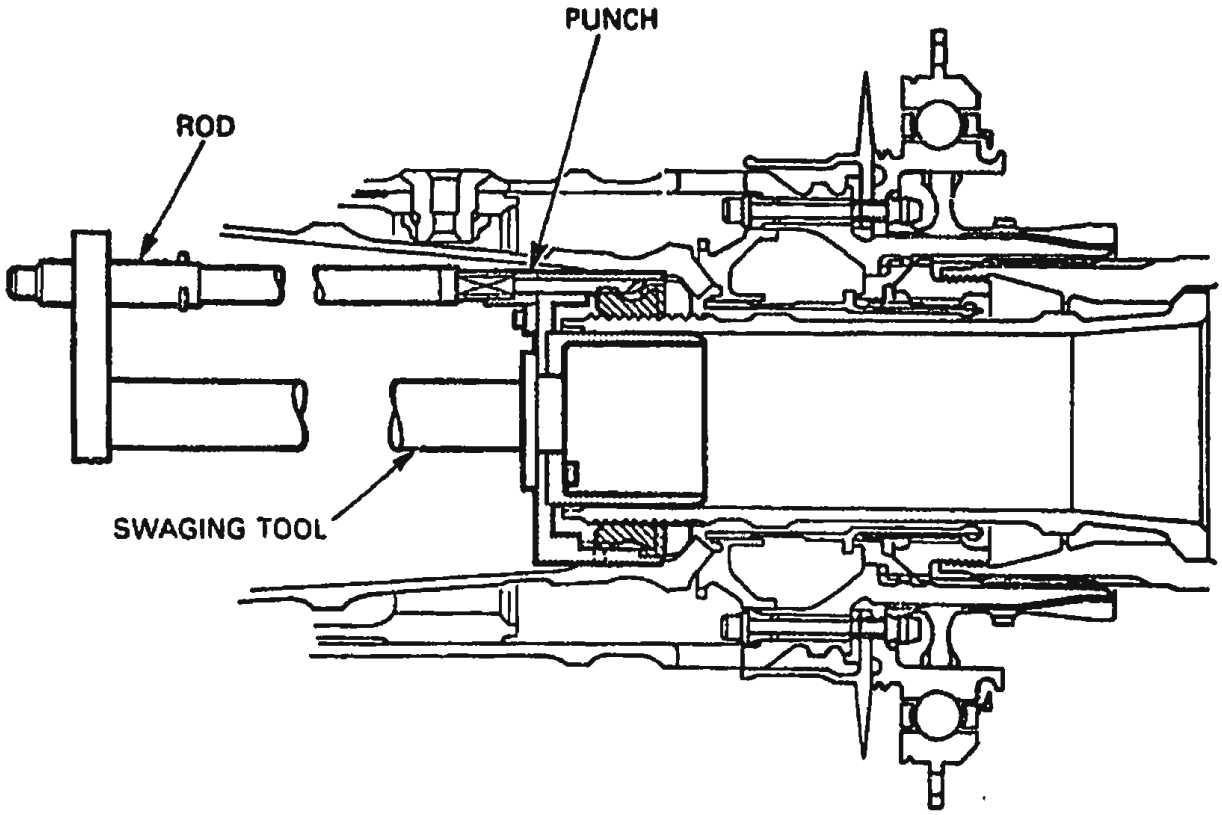



*DETAILS OF ASSEMBLY TOOL

1 Engage nut to retain tube and push-plate assembly in contact with stop ring
2 Fit cupwasher and thrust ring to plug
3 Pass assembly tool through bore at front of assembled L P compressor rotor and locate in bore of assembled tubular bolt
4 Locate thrust ring and cupwasher dogs in tubular bolt slots
5 Release nut
6 Push thrust ring and cupwasher on to tubular bolt and into full contact with fail-safe shaft
7 Withdraw assembly tool

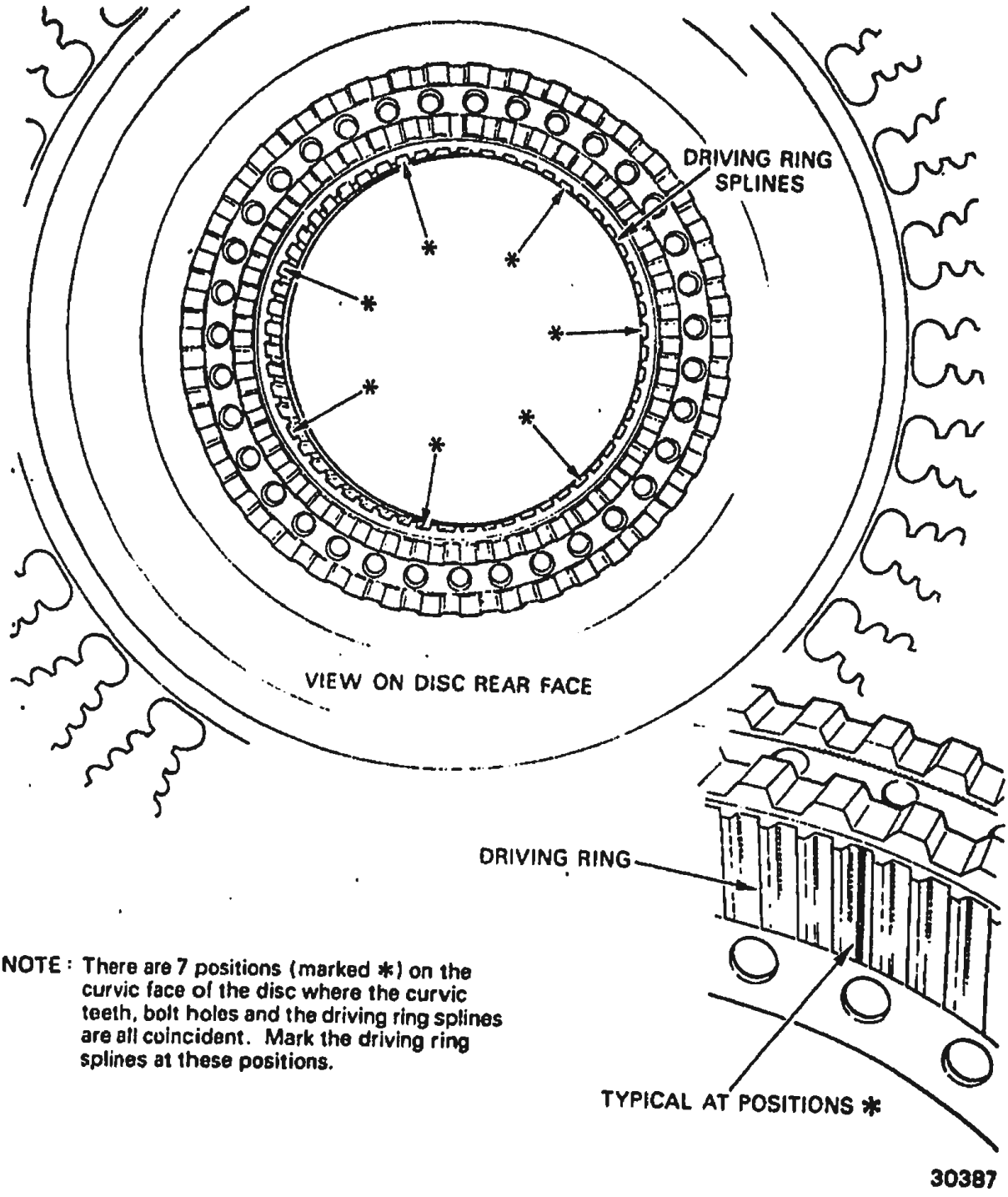
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Fit thrust ring and cupwasher to shaft retaining bolt
Fig.416



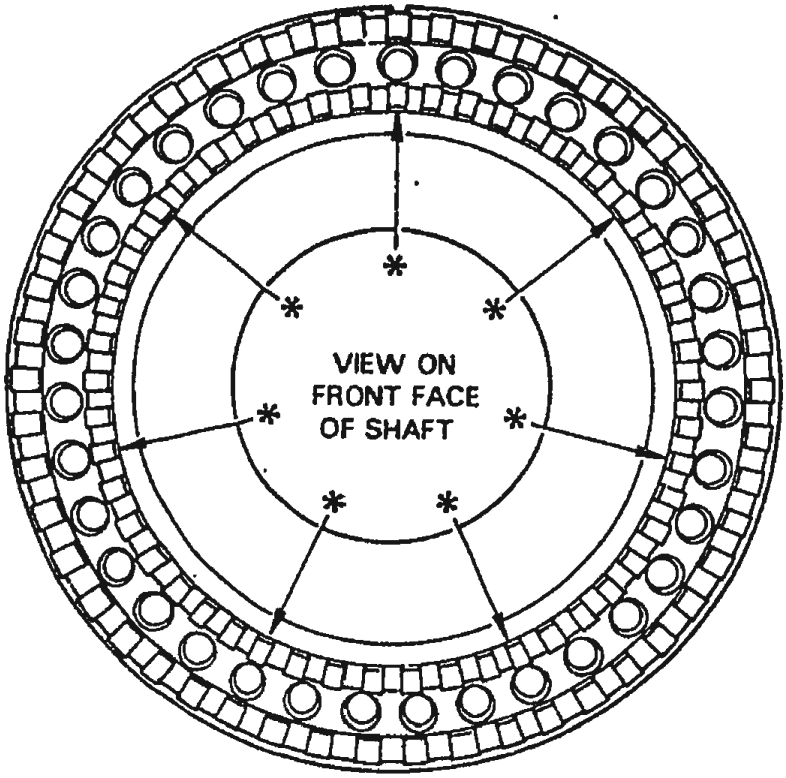

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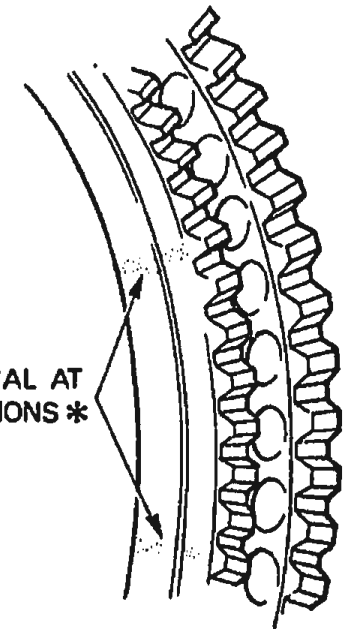
Lock fail-safe shaft retaining nut
Fig.417




NOTE : There are 7 positions (marked *) on the curvic face of the disc where the curvic teeth, bolt holes and the driving ring splines are all coincident. Mark the driving ring splines at these positions.

Compressor disc correlation
Fig.418




NOTE : There are 7 postions (marked *) on the curvic face of the shaft where the curvic teeth and bolt holes are coincident, mark the bore at these positions

30487A

Compressor shaft correlation
Fig.419

(18) Lock fail-safe shaft retaining nut, fig.417.

(a) Fit punch, HU.20073, to swaging tool, HU.20072/2

(b) Enter swaging tool through bore of fail-safe shaft, align punch with scallop in nut and engage tool in bore of tubular bolt.

(c) Strike outer end of rod with hammer to depress cupwasher rim into nut scallop.

(d) Withdraw swaging tool and rotate to align punch with scallop in nut directly opposite to previously locked position and engage tool in bore of tubular bolt.

(e) Strike outer end of rod with hammer to depress cupwasher rim into nut scallop.

(f) Remove swaging tool.

(19) Check that clearance of 0.125in. to 0.250in. exists between rear of fail-safe shaft flange and forward face of L.P. compressor disc.

7. Install parts removed during 'Prepare to remove L.P. compressor disc and blades'

All parts detailed in the following procedures are to be checked for freedom from damage, distortion and corrosion prior to installation.

A. Install air intake adapter

(1) Verify that PROXIMITY SWITCH 2 (H3) on Flight Engineers/Second Officers aft circuit breaker panel CB3 is open and tagged.

(2) Verify that tail-skid is retracted.

(3) Position air intake adapter, mounted in adapter dolly (fig.408 (Sheet 1)) below intake adapter aperture.

(4) Install davit assemblies in applicable holes of mid fixed beams, centering davit with air intake adapter aperture.

(5) Compress adapter slip joint and attach sling to adapter, fig.408 (Sheet 2 and 3).

(6) Attach portable hoists to davit assembly arms, fig.408 (Sheet 1).

(7) Lower hoist cables and attach cables to adapter sling end fittings.

(8) Release adapter from dolly, fig.408 (Sheet 1).

(9) Hoist adapter carefully to position between S-duct and L.P. compressor case front flange.

(10) Verify that alignment fittings on adapter mate with alignment fittings on S-duct as adapter is raised to position, fig.408 (Sheet 2 and 3).

(11) Fit washers and bolts to secure adapter to S-duct, fig.408 (Sheet 2 and 3): tighten bolts.

(12) Align adapter with compressor case front flange then fit bolts and washers to secure, fig.408 (Sheet 2); tighten bolts.

NOTE: The aft end of the S-duct is not rigidly attached to aircraft structure. It may be necessary to raise the adapter and S-duct to mate with compressor case front flange.

(13) Disconnect adapter sling, fig.408 (Sheet 2 and 3), from adapter, lower to ground and remove from hoists.

NOTE: Store adapter sling in adapter dolly storage box, fig.408 (Sheet 1).

(14) Remove portable hoists and davit assemblies.

(15) Tighten fire detector loop clamps.

(16) Fit, connect, torque tighten and wirelock P1 probe tube assembly, fig.407.

(17) Position probe tube clamps; fit and tighten screws to secure, fig.407.

(18) Connect adapter access door proximity switches and wire harness to adapter access doors.

(19) Install L.P. compressor spinner and anti-icing tube, (Ref. 72-31-03).

(20) Position starter duct section and fit coupling clamps to secure, fig.406.

(21) Remove fuel line protective caps and fit new seal ring to connector, fig.405.

(22) Fit bolts, washers and nuts to secure connector.

(23) Torque tighten nuts to standard loading.

(24) Remove protective caps from B1 and C1 pump hydraulic lines, fig.404.

(25) Connect and tighten hydraulic lines, fig.404.

(26) Wire lock connectors.

B. Close L.H. and R.H. lower hinged cowls, fig.403

(1) Release and stow cowl panel strut assemblies.

(2) Close both lower hinged cowl panels.

(3) Engage hook-type latches along bottom edge of L.H. hinged cowl and verify that rear edge of cowl mates with rub strip on cowl seal assembly.

(4) Engage and lock forward pin latch assembly.

(5) Lock hook type latches.

C. Close L.H. and R.H. upper hinged cowls, fig.402.

(1) Release and stow strut assemblies.

(2) Close upper cowl panel.

(3) Engage pin-latches along bottom edge of panel and verify that rear edge of cowl mates with rub strip on cowl seal assembly.

(4) Engage and lock cowl panel forward pin latches.

(5) Repeat procedure (1) through (4) for opposite hinged cowl.

(6) Remove engine No.2 workstand, fig.401, from aircraft.

(7) Remove engine No.2 inelt duct cover, Ref.401

D. Extend tail skid

WARNING: VERIFY THE FOLLOWING BEFORE PRESSURIZING ANY HYDRAULIC SYSTEM:

LANDING GEAR DOWNLOCK SAFETY PINS AND DOOR SAFETY DEVICES ARE INSTALLED.

TRAVEL AREAS OF ALL FLIGHT CONTROL SURFACES AND MAIN GEAR DOORS ARE CLEAR OF PERSONNEL AND GROUND EQUIPMENT.

THE AFFECTED HYDRAULIC SYSTEMS CAN ACCEPT HYDRAULIC PRESSURE.

(1) Connect external power source to receptacle on forward lower fuselage, zone 124 (FS458).

NOTE: External power source must be capable of supplying 115/200 V ac, 3-phase, 400 Hz, ABC phase rotation with a capacity of 90 kVa continuous.

(2) Energize external power source.

(3) Energize aircraft buses using the following procedure:

(a) Check that EXT POWER AVAIL and EXT POWER NOT IN USE lights come on; lights are located on Flight Engineers/Second Officers electrical control panel, zone 215, and in receptacle area.

(b) Place volts-frequency selector switch in EXT POWER position and check for correct voltage and frequency as indicated on adjacent voltage and frequency meters.

(c) Place essential bus selector switch on NORM B3-(G1) position.

(d) Place EXT PWR switch in ON position and check that ON indication (above switch) comes on, AVAIL light remains on and NOT IN USE light (in receptacle area) goes off.

(4) Open hydraulic service centre access doors 147AB and 147BB to operate HYDRAULIC SERVICE PANEL CONTROLS or gain access to Flight Engineers/Second Officers HYDRAULIC SYSTEM control panel, zone 215.

(5) Pressurize hydraulic system A as follows:

To pressurize system from hydraulic service centre;

(a) Place B SYS MOTOR PUMP toggle switch to ON, and B to A PTU momentary switch to START.

To pressurize system from Flight Engineers/Second Officers panel;

(a) Depress B3 AC PUMP and B-A PTU switchlights to ON.

(6) Open panel 318 BA and place tailskid ground service switch to EXTEND position; verify that tailskid extends.

(7) Close panel ensuring that warning flag is folded in position and not visible.

(8) Shut-off hydraulic system A pressure as follows:

(a) Hydraulic service centre

Place HYDRAULIC SERVICE PANEL switches to OFF/STOP and rotate RESERVOIR SELECTOR switch to OFF.

(b) Flight Engineers/Second Officers panel.

Release applicable Flight Engineers/Second Officers HYDRAULIC SYSTEM panel switches (light out).

(9) Turn off electrical power.

Place all associated switches, including BATTERY switch, in OFF position then de-energize and disconnect external power source.

E. On flight Engineers/Second Officers aft circuit panel CB3, zone 215, remove tag and close circuit breaker PROXIMITY SWITCH 2 (H3).

F. On pilots overhead ENGINE START panel, zone 210, remove tag from applicable engine start switch.

G. Remove No.2 engine inlet duct cover if fitted.

6. Test Engine

Test engine as detailed in Aircraft Maintenance Manual 71-00-00, Adjustment/Test.

## LOW PRESSURE (L.P.) COMPRESSOR ROTOR DISC AND BLADES - INSPECTION/CHECK

R The Inspection/Check information for L.P. compressor blades is
R contained in Chapter 72-31-05, page block 601.

## LOW PRESSURE (L.P.) COMPRESSOR ROTOR DISC AND BLADES - CLEANING/PAINTING

R The Cleaning/Painting information for L.P. compressor blades is
R contained in Chapter 72-31-05, page block 701.

## LOW PRESSURE (L.P.) COMPRESSOR ROTOR DISC AND BLADES - APPROVED REPAIRS

R The Approved Repairs information for L.P. compressor blades is
R contained in Chapter 72-31-05, page block 801.

R L.P. COMPRESSOR SPINNER AND ANTI-ICING TUBES -
R REMOVAL/INSTALLATION

R WARNING: FIT HOT AND COLD STREAM OUTLET BLANKS TO PREVENT
R L.P. COMPRESSOR WINDMILLING

R CAUTION: THE WEIGHT OF THE SPINNER IS APPROXIMATELY
R 15.5 LB. (7 KG)

R 1. Remove Compressor Spinner and Anti-icing Tube

R A. Equipment required:

R 289200 Protective work mats

R B. No 1 and No 3 engines; position protective work
R mats in nose cowl air intake ensuring red warning
R pennants are clearly visible external of the aircraft.

R C. No 2 engine; open access door 431AZ, position
R protective work mats in intake ensuring red warning
R pennants are clearly visible external of the aircraft.

R D. Refer to fig.401; remove bolts (1).

R E. Remove nose cap (2).

R F. Withdraw anti-icing tube (3).

R G. Support spinner (4), remove bolts (5); remove spinner
R and place base on a flat surface.

R 2. Install Compressor Spinner and Anti-icing Tube

R A. Equipment required:

R 289200 Protective work mats

R B. Materials required:

R Dry film lubricant: British spec E.3699

R C. Ensure protective mats are positioned in intakes
R as detailed in 1. B. and C.

R NOTE: To assist correct positional assembly a
R correlation mark in the form of a machined
R scallop, or flat, appears on each item.

R D. Refer to fig.401, apply a thin coat of dry film
R lubricant to the mating faces of spinner (4) and
R thrust ring.

R E. Position spinner to thrust ring, fit and secure
R bolts (5).

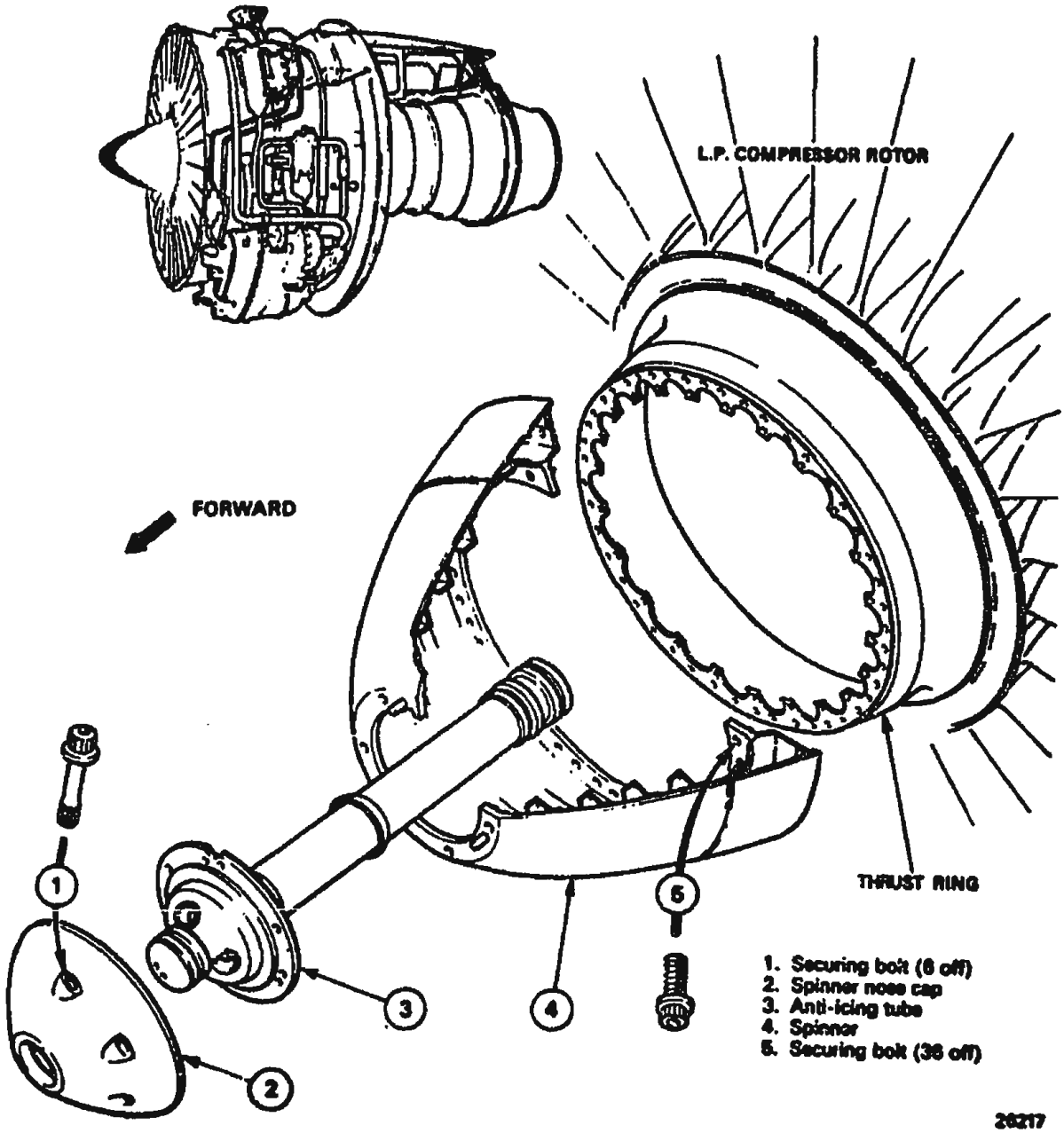
R F. Apply a thin coat of dry film lubricant to the
R mating faces of the spinner (4), anti-icing tube (3)
R and nose cap (2)

R G. Position anti-icing tube to spinner, carefully
R entering metal seal ring into rear location in
R engine shaft; align correlation scallops and
R ensure positive location on dowels.

R H. Position nose cap (2) on anti-icing tube, aligning
R correlation flat to tube scallop, ensure positive
R location on dowels and secure with bolts (1).

R J. No 1 and No 3 engines, remove protective work mats
R from air intake.

R K. No.2 engine, remove protective work mats from air
R intake and close access door 431AZ.




R L.P. compressor spinner and anti-icing tube
R removal/installation
R Fig.401

R EFFECTIVITY: ALL
R

R L.P. COMPRESSOR SPINNER AND ANTI-ICING TUBES
R INSPECTION/CHECK

R 1. Inspection/Check L.P. Compressor Spinnner

R A. Indentations and cracks.

R (1) Inspect the spinner for identations, distortion
R and cracks.

R B. Acceptance standards.

R (1) Cracks in a spinner are unacceptable.

R (2) Identations not causing local distortion are
R acceptable if they do not feature nicks,
R sharp edges, or peaks.

R (3) Indentations resulting in local distortion not
R exceeding 0.050 in. (1,270 mm.) depth are acceptable
R providing they do not feature nicks, sharp edges, or
R peaks.

# L.P. COMPRESSOR ROTOR BLADES - MAINTENANCE PRACTICES

## 1. General

During engine running, it is normal for L.P. compressor (fan) blade strut (clappers) to lock-up and to unlock during engine rundown. Blade strut lock-up is not detrimental to engine performance.

However if this lock-up condition is suspected to be the cause of engine vibration, the blade strut should be unlocked as detailed in the following procedure.

Engine vibration may also indicate excessive fan blade axial clearances.

## 2. Blade strut (clapper) unlock procedure

A. Equipment required:

| | |
|---|---|
| 289200 or C 4G 4342 | Protective work mat. |

B. Material required:

| | | | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|---|---|
| R | (1) | Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | B.S.4487: 1969 | MIL-T-81533 | 1/21 |
| R | | or alternatives | | | |
| R R | | Methylethylketone (M.E.K.) | - | - | 135 |
| R | | Cleaning solvent | - | - | 1/257 |
| R | (2) | Polishing pad Scotchbrite | Type A.7447 Very fine (Maroon) | - | 583 |

| | | | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|---|---|
| R | (3) | Dry film lubricant Colloidal Molybdenum disulphide in toluene | Achesons Dag 709 | | 444 |
| R | | or alternatives | | | |
| R R | | Solid lubricant paste | Molykote GN paste | - | 4/49 |
| R R | | Lubricant paste | Molykote G rapid paste | - | 4/50 |
| R | | Bonded lubricant | Molykote 321R | - | 4/51 |
| R R | | Dry film anti-scuffing spay | Rocol AS | - | 4/52 |
| R R | | Anti-scuffing paste | Rocol ASP | - | 4/53 |
| R R | | Inorganic anti-scuffing spray | Rocol DFSM | - | 4/54 |
| R | | Drislide | - | - | 4/58 |

C. Tag throttle and thrust reverser levers and APU/GND AIR reverser switches.

D. Open and tag appropriate START AIR VALVE circuit breaker N.3 N.9 or N.15 on Flight Engineer/Second Officers aft circuit breaker panel C.B.3 zone 215.

E. Tag appropriate ENGINE START panel switchlights.

F. Position work mat in nose cowl air intake ensuring red warning pennants are clearly visible from aircraft exterior.

G. WARNING: 1. EAR DEFENDERS MUST BE WORN WHEN UNLOCKING L.P. COMPRESSOR BLADE STRUTS (CLAPPERS).

2. WHEN SPINNING THE L.P. COMPRESSOR CARE MUST BE TAKEN TO AVOID TRAPPING FINGERS BETWEEN ROTOR BLADES AND I.P. COMPRESSOR STATIC INLET GUIDE VANE.

Inspect the L.P. compressor rotor blades for blade strut (clapper) lockup. This can be accomplished by spinning the L.P. compressor by hand, any locked blades will not give the characteristic clanking noise. If locked, rotate the compressor, determine and mark any blade tip that is out of alignment.

H. To unlock a blade strut (clapper), rotate the L.P. compressor until a marked blade is at top dead centre. Then using a soft face hammer on the blade strut leading edge aerofoil runout radius, strike the adjacent blade a tangential blow in the direction of rotation.

J. WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.

Cold liquid degrease the blade strut mating faces as follows:

(1) Working at top dead centre (T.D.C.) where the gap between adjacent blade struts (clappers) is largest, clean the strut mating faces by cold liquid degreasing using a lint-free cloth if necessary.

(2) Carry out the procedure described in (1) at each strut (clapper) mating face location after rotating to T.D.C.

(3) Inspect the blade strut (clapper) abutment faces as detailed in 72-31-05 Inspection/Check.

NOTE: If further cleaning is required in order to remove stubborn deposits of dry film lubricant or to improve surface to assist inspection, lightly polish (using polishing pad supported on a non-metalic spatula) strut (clapper) mating faces.

K. Fan blade axial clearance check

(1) Inspect fan blade axial clearances as detailed in 72-31-05 Inspection/Check.

L. Apply dry film lubricant to the blade strut mating faces as follows:

R WARNING: 1. DRY FILM LUBRICANTS, IN PARTICULAR THOSE
R APPLIED BY BRUSH OR SPRAY CONTAIN HARMFUL
R SOLVENTS SUCH AS TOLUENE AND DICHLOROMETHANE.
R DRY FILM LUBRICANTS CONTAINING TOLUENE ARE
R HIGHLY FLAMMABLE. DO NOT USE ON A HOT ENGINE.
ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.

2. WHEN USED ON NUMBER TWO ENGINE THE OPERATOR MUST WEAR A FACE MASK.

3. MOLYKOTE 321R CONTAINS CHLORINATED HYDROCARBON SOLVENT, ENSURE ADEQUATE VENTILATION.

(1) When strut (clapper) mating faces are clean and dry apply dry film lubricant to the strut mating faces working at T.D.C. position where the gap between adjacent blade strut mating faces is largest. The use of a small brush is recommended to ensure that dry film lubricant is thoroughly applied over the full area of both mating faces of blade struts (clappers).

(2) Repeat the procedure described in (1) at all the remaining strut (clapper) mating faces after rotating each to T.D.C.

(3) Remove any excess lubricant.

M. Remove work mat from nose cowl air intake.

N. Remove tags and close circuit breakers opened in operations C, D and E.

# L.P. COMPRESSOR ROTOR BLADES - REMOVAL/INSTALLATION

## 1. General

When an L.P. compressor blade(s) is damaged beyond limits and a replacement blade(s) is to be fitted, the balance of the L.P. compressor assembly must be maintained.

CR Four methods are detailed, Methods 1and 2 are dependent on the moment weight of the replacement blade available, that instruct damaged blade removal, replacement blade selection and fitting.
R Method 4, Utilizes replacement of a complete set of blades with
R another complete set of servicable blades.

Method 1 utilizes a replacement blade whose moment weight is within ± 5 oz.in. of the damaged blade moment weight. In this case no balance correction is required.

Where difficulty is experienced in obtaining a replacement L.P. compressor blade of the required moment weight it is permissible to fit one blade in the L.P. compressor assembly with a moment weight within ±15 oz.in. of the damaged blade moment weight, using procedure given in Method 1, providing the following are adhered to:

A. The replacement blade must be marked with a white square on the front face of the blade root shank and the difference in the moment weights of the blades must be recorded to assist servicing personnel should further damage occur.

B. Should the L.P. compressor be damaged again, the moment weight of the replacement blade(s) must be within ±5 oz.in. of the original moment weight(s).

Method 2 utilizes a lighter or heavier replacement blade up to a maximum difference of 145 oz.in. in moment weight to the damaged blade. The moment weight difference is compensated for by selecting either single, pairs or a combination of 1, 2 or 3 bolt balancing plates and bolting the plate(s) to the thrust ring balancing flange.

Method 4, utilizes a complete set of blades being replaced by a complete set of serviceable blades (that have at sometime, been sequenced by computer distribution) obtained from a spare L.P. compressor rotor module or a spare engine. In this event, it is not necessary to effect individual blade balancing.

The blade fitted at the L.P. compressor rotor disc number 1 position of the spare module or engine is to be fitted at the rotor disc number 1 position of the installed engine. The remaining replacement blades are to be fitted in numerical sequence (use a felt tip pen to number replacement blades 1 to 33) as arrowed on the L.P. compressor rotor disc of the installed engine.

When applying this option, the thrust ring together with the balancing weight(s) is removed (use a felt tip pen to correlate thrust ring position with rotor disc) from the installed engine, the replacement blades fitted and the thrust ring and balance weight(s) re-fitted in the original position on the rotor disc of the installed engine.

On completion, in order to confirm that vibration levels are within limits, a vibration survey (Ref.71-00-00, Adjustment/Test,
C Test 10) is effected as detailed in the applicable method.

C CAUTION: IF TOTAL WEIGHT OF ALL BALANCE PLATES FITTED TO
C THRUST RING DOES NOT EXCEED 9.0 OZ. (255.15 GM) FAN
C ASSEMBLY CAN CONTINUE IN SERVICE TO NEXT OVERHAUL.

C CAUTION: THE MAXIMUM WEIGHT OF 9.0 OZ. (255.15 GM) CAN BE
C EXCEEDED BY A FURTHER 13.5 OZ. (382.72 GM) FOR A
C RESTRICTED PERIOD OF 25 FLIGHTS OR 125 HOURS
C WHICHEVER IS THE SHORTER.

C A LOG BOOK ENTRY IS REQUIRED EVERY TIME THAT THE
C 9.0 OZ. (255.15 GM) LIMIT IS EXCEEDED.

C (1 HOLE BALANCE WEIGHT, BOLTS AND NUTS, 2.25 OZ.
C 2 HOLE BALANCE WEIGHT, BOLTS AND NUTS, 4.5 OZ.
C 3 HOLE BALANCE WEIGHT, BOLTS AND NUTS, 6.75 OZ.)

CR Method 4 A is the same as method 4 except that up to three
CR blades may be replaced without regard to moment - weight, if
CR the revised set is sequenced by a computer distribution. A
CR computer distribution may be obtained from MCI Scheduling
CR (X-4433) by providing module number and serial numbers of
CR removed blades and replacement blades.

. C

FIGURE DELETED

Determine replacement blade fitment method
Fig.401

2. Preparation Operations - All Methods

CAUTION: THE WEIGHT OF ONE L.P. COMPRESSOR BLADE IS APPROXIMATELY 16 LB. (7 KG.).

Referenced Procedures

| | |
|---|---|
| 6-40-00 | Exterior Access Doors and Removable Panels - Description and Operation |
| 6-50-00 | Interior Access Doors and Removable Panels - Description and Operation |
| 72-31-03 | L.P. Compressor Spinner and Anti-icing Tubes - Maintenance Practices. |

A. Equipment required:

| | |
|---|---|
| 289200 or C 4G 4342 or XUT.40959 | Protective work mats<br>Nose cowl work platform |

B. Engines No.1 and 3

(1) Position protective work mats or work platform in nose cowl air intake ensuring red warning pennants are clearly visible from aircraft exterior.

C. Engine No.2

(1) Open access doors 433BL (Ref. 6-50-00) and 431AZ (Ref. 6-40-00).

(2) Position protective work mats in air intake ensuring red warning pennants are clearly visible from aircraft exterior.

D. Remove L.P. compressor spinner and anti-icing tubes (Ref. 72-31-03).

E. Fan blade axial clearance check.

F. Refer to fig.402, using felt tip pen, alignment mark thrust ring (2) to disc to facilitate correct positioning of thrust ring on re-assembly, then remove screws and nuts (1) and remove thrust ring.

(1) Inspect fan blade axial clearances as detailed in 72-31-05 Inspection/Check.

F. Methods 1 and 2

(1) Record moment weight of damaged blade, marked on underside of blade front lip (Ref.fig.402) e.g. 6172.8.

NOTE: If a balance weight is bonded to blade root of damaged blade (Ref. fig.404), add moment weight marked on the balance weight to the damaged blade moment weight to obtain total moment weight.

G. Method 1 and 2

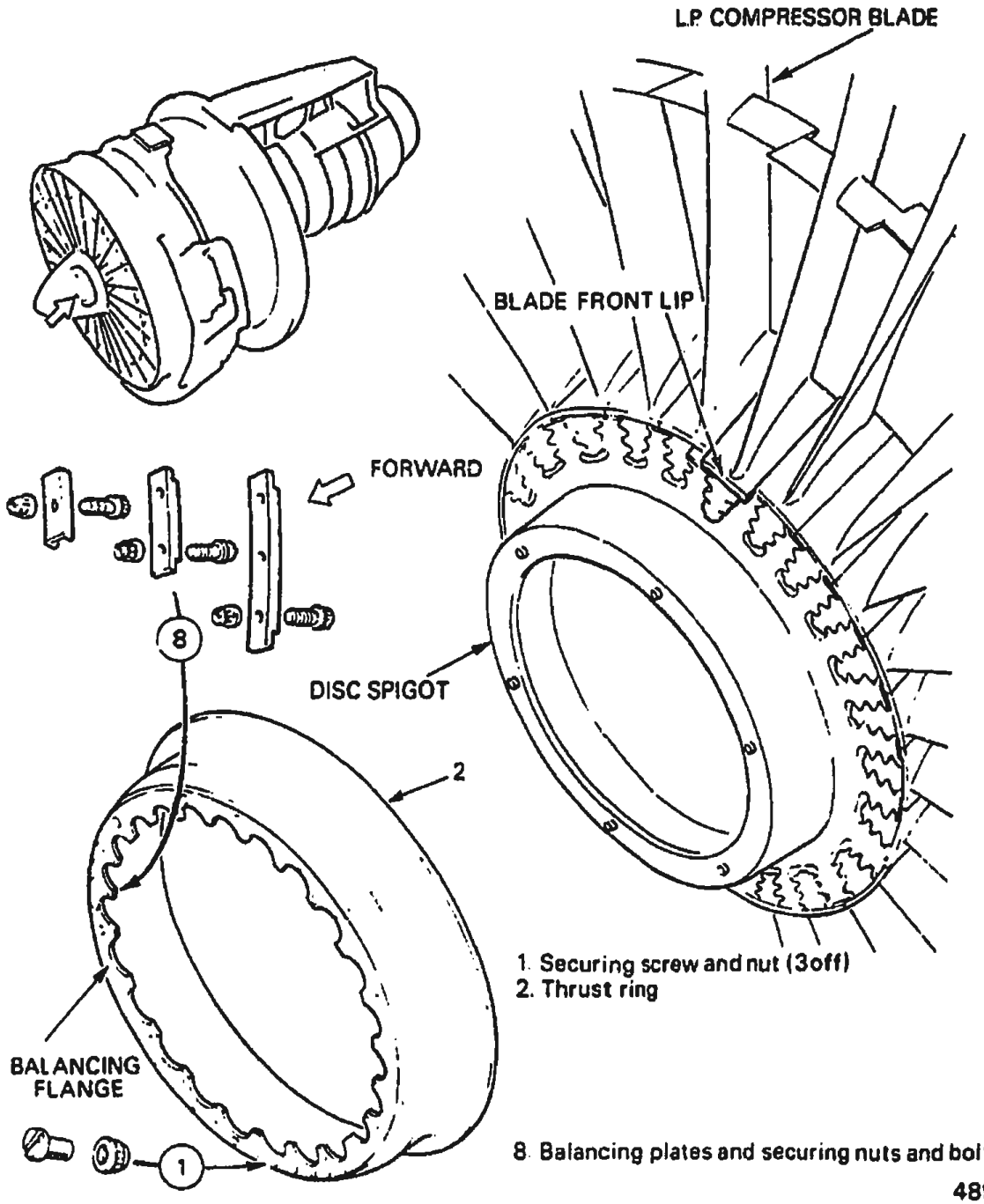
(1) Select a replacement blade nearest in moment weight to that of the damaged blade; calculate and record
C moment weight difference between the two blades, and proceed with appropriate Method.

CR H. Method 4/4A

(1) CAUTION: L.P. COMPRESSOR ROTOR BLADES WITHOUT S.B.72-5540 CAN BE FITTED TO ROTOR DISCS WITH S.B.72-5540 BUT MUST BE RESTRICTED TO 25 FLIGHTS OR 125 HOURS WHICHEVER IS THE SHORTER. L.P. COMPRESSOR ROTOR BLADES WITH S.B.72-5540 CAN BE FITTED TO A ROTOR DISC WITHOUT S.B.72-5540 WITHOUT RESTRICTION.

Select a complete set of serviceable blades (that have at sometime been sequenced by computer distribution) from a spare L.P. compressor rotor module or a spare engine.

CR NOTE: For Method 4A up to three blades may be
CR replaced without regard to moment - weight if
CR the revised set is sequenced by a computer
CR distribution. A computer distribution may be
CR obtained from MCI Scheduling (X-4433) by
CR providing module number and serial numbers of
CR removed blades and replacement blades

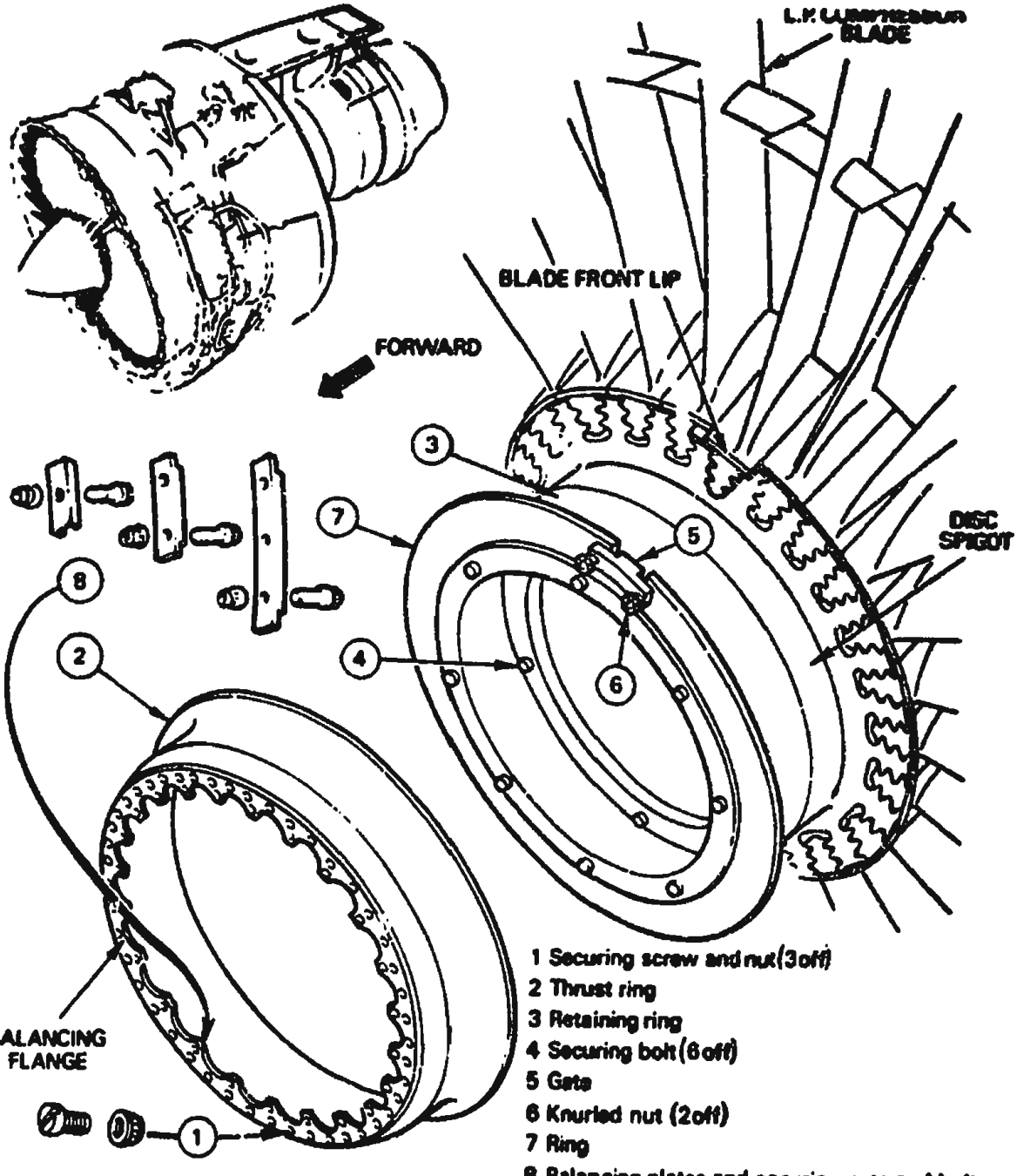



1. Securing screw and nut (3off)
2. Thrust ring

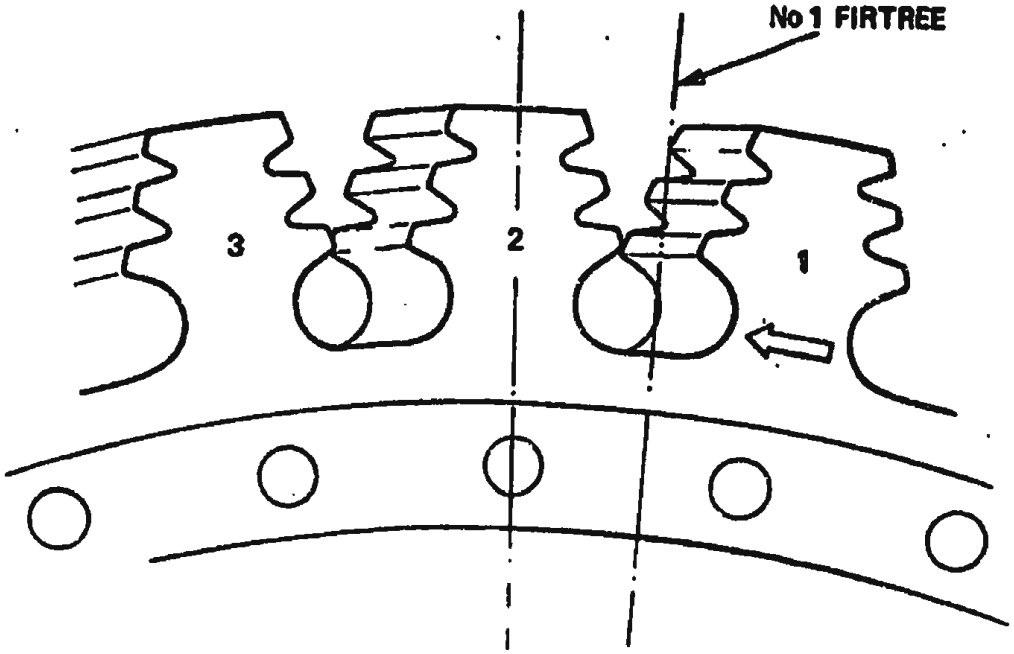
8. Balancing plates and securing nuts and bolts

48981

C
. C L.P. compressor rotor blade removal/installation
Fig.402 (Sheet 1)




R L.P. compressor rotor blade removal/installation
R Fig.402 (Sheet 2)




VIEW ON DISC FRONT FACE

32009A

R L.P. compressor rotor blade removal/installation
R Fig.402 (Sheet 3)

EFFECTIVITY: ALL

3. Method 1 - Replacement Blade Moment Weight within Plus or Minus 5 oz.in. of Damaged Blade Moment Weight

CAUTION: L.P. COMPRESSOR ROTOR BLADES WITHOUT S.B.72-5540 CAN BE FITTED TO ROTOR DISCS WITH S.B.72-5540 BUT MUST BE RESTRICTED TO 25 FLIGHTS OR 125 HOURS WHICHEVER IS THE SHORTER.

Service Bulletins referred to:

72-5540 L.P. Compressor (Fan) Blade and Disc-Application of PL237 Anit-frettage Treatment to Fir Tree Roots.

Referenced Procedures:

6-40-00 Exterior Access Doors and Removable Panels - Description and Operation
6-50-00 Interior Access Doors and Removable Panels - Description and Operation
C 71-00-00 Power Plant - Adjustment/Test (Test 10)
72-31-03 L.P. Compressor Spinner and Anti-icing Tubes - Maintenance Practices

Illustrated Parts Catalogue References:

The I.P.C. section where parts disturbed during the following operations can be located is as follows:

72-31-02 L.P. Compressor Rotor Disc and Blades

A. Equipment required:

HU.21567 Retaining ring
Small, clean brush

B. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | B.S.4487: | Mil-T-81533 | 1/21 |

| | | | |
|---|---|---|---|
| Dry film lubricant | Electrofilm 77/S | | 4/43E |
| Liquid paraffin B.P. | - | - | 1020 |
| Felt or fibre tip temporary marker | - | - | 262 |

C. Remove Damaged Blade

C (1) Deleted.

(2) With damaged blade at T.D.C., pull blade forward until clapper contact prevents further movement. Working anti-clockwise (viewed from front) repeat with each blade, rotating L.P. compressor so that blade being pulled forward is at T.D.C.

C (3) Repeat operation (2) several times until all blades are approximately 6 inches forward.

C (4) Withdraw damaged blade.

D. Install Replacement Blade

(1) Prior to installing replacement blades with S.B.72-5540 carry out the following Inspection/Check:

(a) Galling

(i) Up to 0.002in. (0,051 mm.) - Accept.

(ii) In excess of (i) - Reject.

(b) Loss of dry film lubricant is acceptable on condition that it is re-applied at the next convenient opportunity.

(c) The following Fly Home limit applies to the blade fir trees:

If there are not suitable replacement blades available, a blade rejected by the above acceptance standards may be re-installed for a maximum period of 125 hours or 25 flights whichever is the sooner.

. C C C (2) Enter replacement blade in fir tree groove and push rearward until clapper contact prevents further movement.

C (3) Deleted.

(4) Working anti-clockwise (viewed from front), repeat rearward movement with each blade in turn until all blade roots are fully entered in disc.

C (5) Deleted.

(6) CAUTION: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Using degreasing fluid, clean mating faces of thrust ring (2) to disc spigot and allow to dry.

(7) Brush apply a thin coat of dry film lubricant to mating faces of thrust ring and disc spigot.

(8) While lubricant is still wet, fit thrust ring to disc spigot ensuring correct positional location (Ref. para. 2.F.) and secure with screws and nuts (1).

NOTE: If difficulty is experienced in fitting the thrust ring to the disc spigot, repeat operation (5) and heat thrust ring in an oven to 302 deg.F. (150 deg.C.) prior to fitting.

(9) Lubricate blade struts (clappers) (Ref.72-31-05, Maintenance Practices).

(10) Install L.P. compressor spinner and anti-icing tubes (Ref. 72-31-03).

(11) Engines No.1 and 3

(a) Remove protective work mats or work platform from nose cowl air intake.

(12) Engine No.2

(a) Remove protective work mats from air intake.

(b) Close access doors 431AZ (Ref.6-40-00) and 433BL (Ref. 6-50-00).

R (13) Before next flight carry out a vibration survey as
R detailed in Test 10 paragraphs A through G. (Ref.
R 71-00-00, Adjustment/Test) to confirm that vibration
R level is within limits. If during the vibration survey
R the broad band (NORM) vibration is outside limits (Ref.
R 71-00-00, Maintenance Practices) perform paragraph H of
R Test 10 to establish the individual LOW, MED and HIGH
R vibration levels.

R If high broad band (NORM) vibration is associated with
R high, 'LOW' band vibration consideration should be given
R to trim balancing (Ref. 71-00-00, Adjustment/Test, Test
R No.16) otherwise a full vibration survey to Test 10
R (Ref.71-00-00, Adjustment/Test) should be performed.

R NOTE: If during the vibration survey the vibration level
R approaches the limit consideration should be given
R to trim balancing the engine (Ref. 71-00-00,
R Adjustment/Test Test No.16).

4. Method 2 - Restoration of Assembly Balance using Balancing Plates

CAUTION: L.P. COMPRESSOR ROTOR BLADES WITHOUT S.B.72-5540 CAN BE FITTED TO ROTOR DISCS WITH S.B.72-5540 BUT MUST BE RESTRICTED TO 25 FLIGHTS OR 125 HOURS WHICHEVER IS THE SHORTER.

NOTE: Selection and fitting of balancing plates is accomplished before removing damaged blade.

Service Bulletins referred to:

| | |
|---|---|
| 72-5540 | L.P. Compressor (Fan) Blade and Disc-Application of PL237 Anti-frettage Treatment to Fir Tree Roots. |

Referenced Procedures:

| | |
|---|---|
| 6-40-00 | Exterior Access Doors and Removable Panels - Description and Operation |
| 6-50-00 | Interior Access Doors and Removable Panels - Description and Operation |
| C 71-00-00 | Power Plant - Adjustment/Test (Test 10). |
| 72-31-03 | L.P. Compressor Spinner and Anti-icing Tubes - Maintenance Practices |

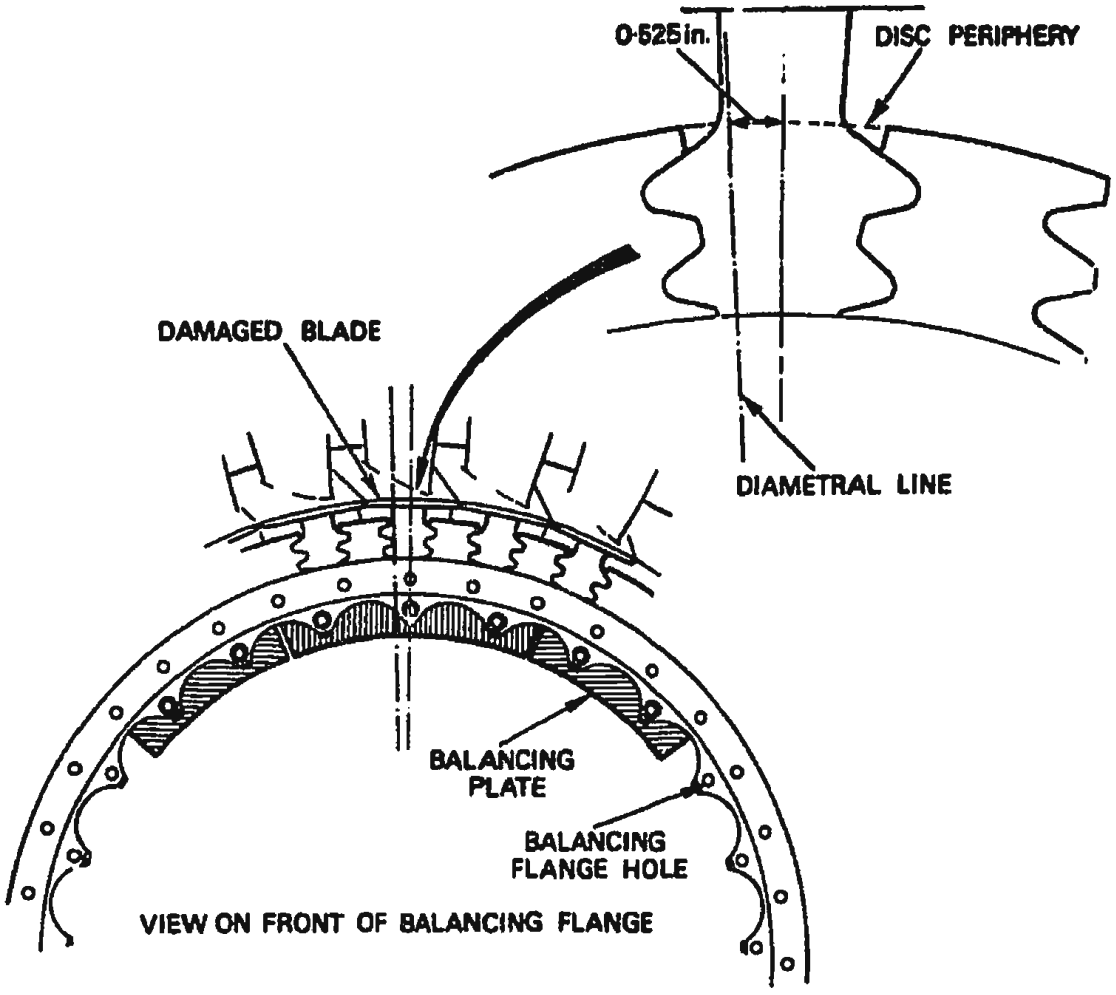
Illustrated Parts Catalogue References:

The I.P.C. section where parts disturbed during the following operations can be located is as follows:

| | |
|---|---|
| 72-31-02 | L.P. Compressor Rotor Disc and Blades. |

A. Equipment required:

C Deleted.




Example: Correction required 60·5oz.in.

Diametral line closer to balancing flange hole than mid position, therefore odd number of unused holes required between balancing plates.

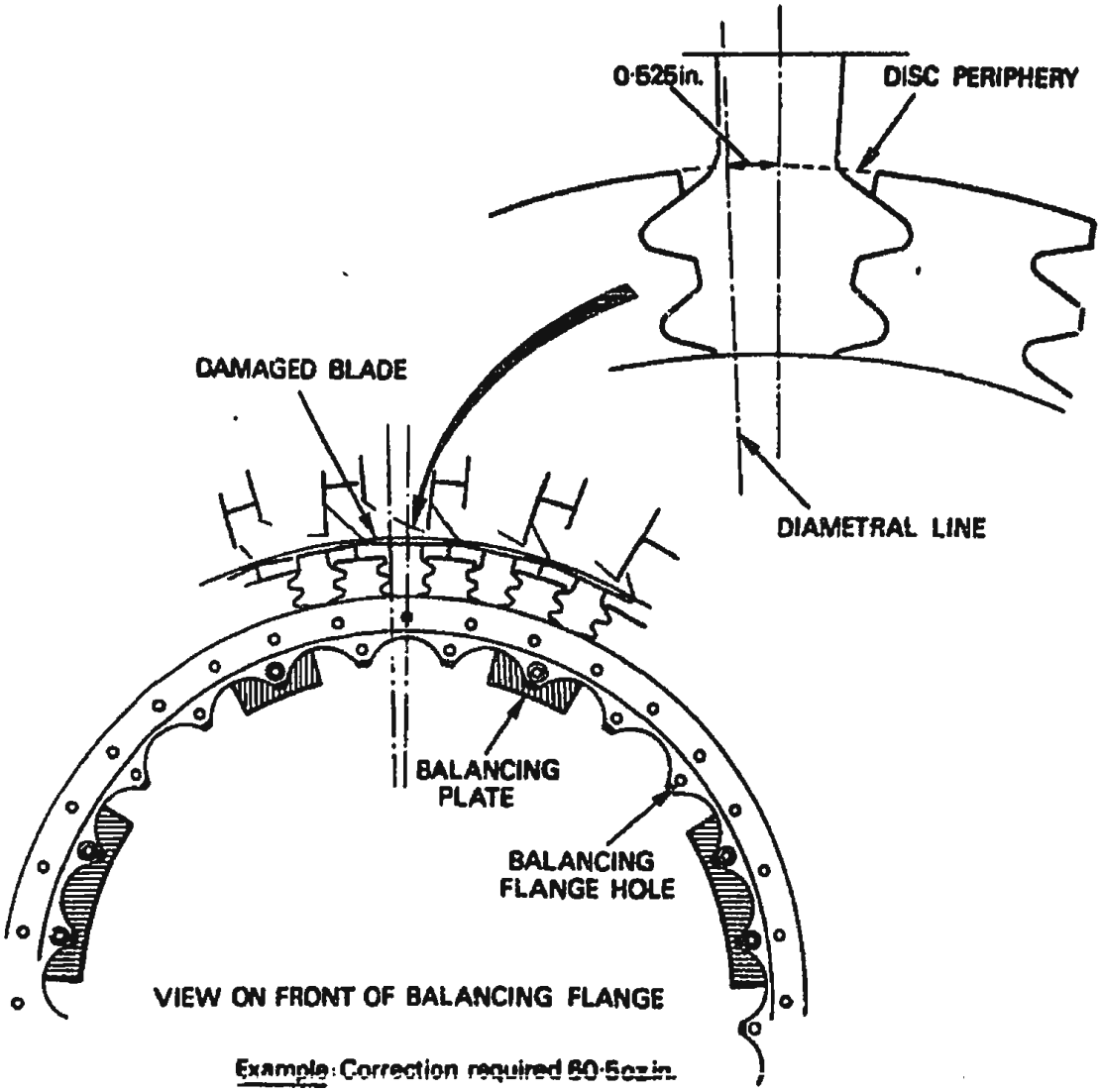
From table 1. 59·2oz.in. correction using 1×3 bolt plate positioned on diametral line.

OR

From table 2. 64 oz.in. correction using 2·2 bolt plates with 3 unused holes between.

32074

Balancing plate positioning - diametral line closer to balancing flange hole
Fig.403 (Sheet 1)




Example: Correction required 60·5oz in.

Diametral line closer to mid position than balancing flange hole, therefore even number of unused holes required between balancing plates.

From table 2. 24·5oz in. correction using 2x2 bolt plates with 8 unused holes between,

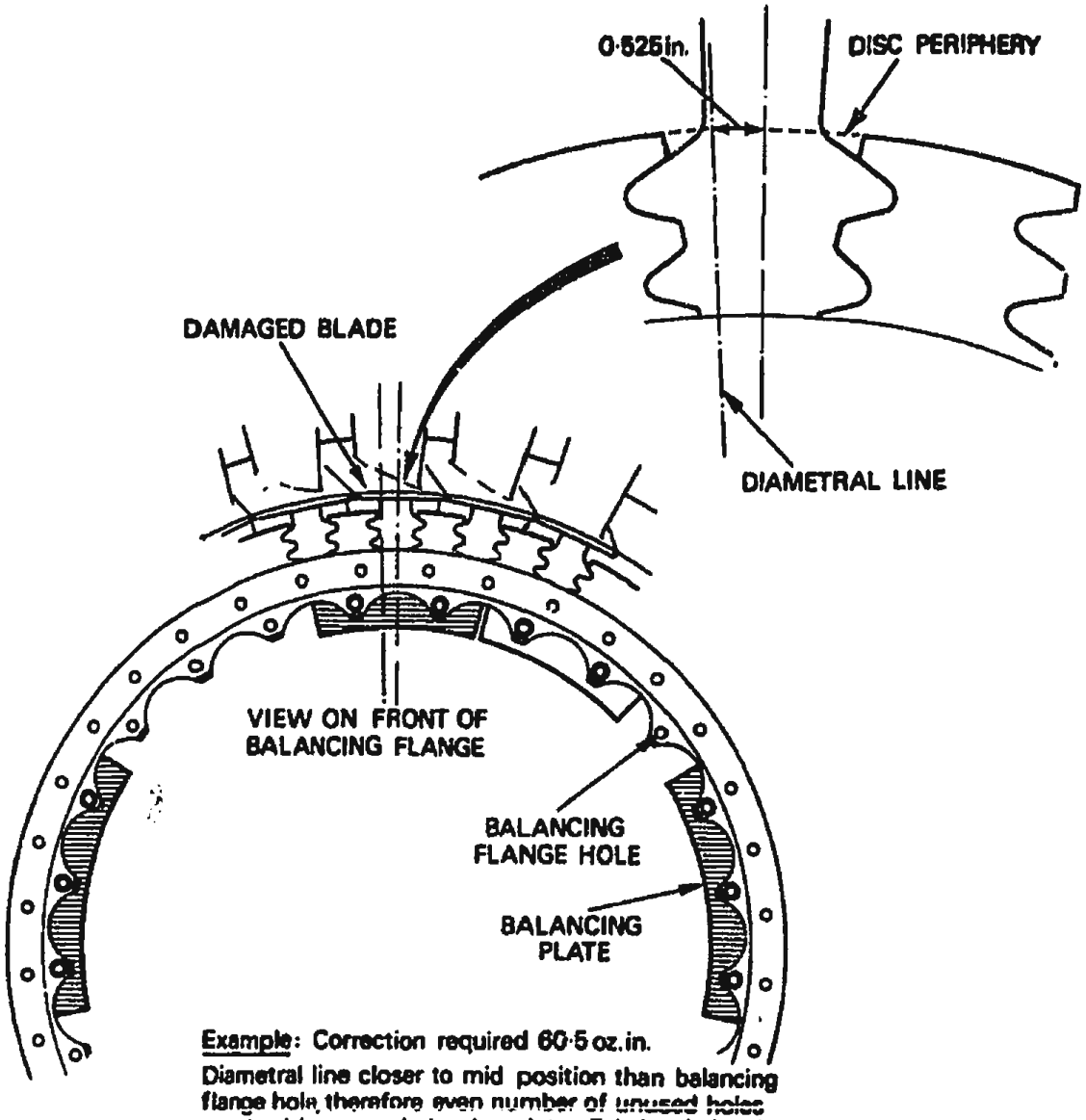
PLUS

36·5oz.in. correction using 2x1 bolt plates with 2 unused holes between.

Total correction 61oz.in.

32075

Balancing plate positioning - diametral line closer to mid position
Fig.403 (Sheet 2)




Example: Correction required 60·5 oz.in.
Diametral line closer to mid position than balancing flange hole, therefore even number of unused holes required between balancing plates. Existing balancing plate is ignored.

From table 2. 22 oz.in. correction using 2×3 bolt plates with 8 unused holes between.
PLUS
From table 1. 39·7 oz.in. correction using 1×2 bolt plate positioned on diametral line.

Total correction 61·7 oz.in.

32078

Balancing plate positioning - diametral line closer to mid position
Fig.403 (Sheet 3)

B. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | B.S.4487: | Mil-T-81533 | 1/21 |
| Dry film lubricant | Electrofilm 77/S | | 4/43E |
| Liquid paraffin B.P. | - | - | 1020 |
| Felt or fibre tip temporary marker | | | 262 |

C. Balance Weight Selection and Fitting

CAUTION: 1. THE MAXIMUM WEIGHT THAT MAY BE FITTED TO THE THRUST RING BALANCING FLANGE IS 9.0 OZ. (255.15 GM.). THIS CORRESPONDS TO FOUR SINGLE BOLT BALANCING PLATES PLUS THEIR ASSOCIATED NUTS AND BOLTS, OR THEIR EQUIVALENT. WHEN CALCULATING THE MAXIMUM WEIGHT, THE POSITION OF THE EXISTING BALANCING PLATE(S) SHOULD BE PRECISELY IDENTIFIED USING A FELT TIP PEN, THE PLATE(S) REMOVED, WEIGHED AND REFITTED IN EXACTLY THE SAME POSITION. THIS IS TO ESTABLISH WHETHER ITS WEIGHT HAS BEEN REDUCED BY PREVIOUS METAL REMOVAL. THE WEIGHT OF THE EXISTING PLATE(S), NUT(S) AND BOLT(S) MUST BE INCLUDED IN THE MAXIMUM OF 9.0 OZ. (255.15 GM.).

2. THE MAXIMUM WEIGHT OF 9.0 OZ. (255.15 GM.) CAN BE EXCEEDED BY A FURTHER 13.5 OZ. (382.72 GM.) FOR A RESTRICTED PERIOD OF 25 FLIGHTS OR 125 HOURS WHICHEVER IS THE SHORTER.

A LOG BOOK ENTRY IS REQUIRED EVERY TIME THAT THE 9.0 OZ. (255.15 GM.) LIMIT IS EXCEEDED.

| | Balancing plates (singles) | Must be fitted on diametral line or with its centre a maximum of half a flange hole pitch from diametral line |
|---|---|---|
| C | 1 bolt Moment Weight | 19.6 Weight 2.25 oz. |
| C | 2 bolt Moment Weight | 39.7 Weight 4.5 oz. |
| C | 3 bolt Moment Weight | 59.2 Weight 6.75 oz. |

Correction obtainable (oz.in.) using balancing plates singly

Table 1

| | Balancing Plates | Number of unused bolt holes between plates | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | 1 bolt | 39 | 38 | 36.5 | 34 | 31.5 | 28.5 | 25 | 21 | 16.5 | 12 | 7.5 | 2.5 |
| C | (2 each) | | | | | | | | | | | | |
| | 2 bolt | 77 | 74 | 69.5 | 64 | 58 | 51 | 42.5 | 33.5 | 24.5 | 15 | 5.0 | |
| C | (2 each) | | | | | | | | | | | | |
| | NOTE: With reference to CAUTION under para.C. regarding maximum weight that may be attached to thrust ring, the following additional line of correction data may be used on a restricted basis of 25 flights or 125 hours whichever is the shorter. | | | | | | | | | | | | |
| | 3 bolt | 110 | 103.5 | 96 | 86.5 | 75.5 | 63.5 | 50.5 | 36.5 | 22 | 7.5 | | |
| C | (2 each) | | | | | | | | | | | | |

Correction obtainable (oz.in.) using balancing plates in pairs

Table 2

Example:

Using table 1 or 2, select balancing plate(s) to give a correction of 60.5 ± 5 oz.in.

Refer to fig.403 (Sheets 1 to 3) for example positional combinations of balancing plates. These examples indicate a replacement blade of lighter moment weight being fitted.

(1) Refer to fig.402, fit thrust ring (2), to disc ensuring correct positional location (Ref. para.2.F.) and temporarily secure using screws and nuts (1).

(2) Position damaged blade at T.D.C. and identify blade to thrust ring as follows:

(a) Replacement blade moment weight is lighter than damaged blade moment weight:

Using a felt tip pen mark position that a diametral line, offset anti-clockwise from damaged blade fir tree root centre line by 0.525in. (13,34 mm.) at disc periphery, cuts thrust ring balancing flange (Ref. fig.403). Establish whether line passes close to a balancing flange hole or mid position between two holes.

(b) Replacement blade moment weight is heavier than damaged blade moment weight:

Using a felt tip pen mark position that a diametral line, offset anti-clockwise from damaged blade fir tree root centre line by 0.525in. (13,34 mm.) at disc periphery, cuts thrust ring balancing flange opposite (180 degrees) damaged blade (Ref. fig.403). Establish whether line passes close to a balancing flange hole or mid position between two holes.

(3) Dependent on position of diametral line to balancing flange hole determine number of unused holes (Ref. fig. 403) and using table 1 or 2 select a balancing plate or a combination of balancing plates corresponding to within ± 5 oz.in. of moment weight difference calculated in para.2.G.

(4) Fit balancing plate(s) to thrust ring.

(a) If moment weight of replacement blade is less than moment weight of damaged blade, using positional arrangement determined in operation (3) position balancing plate(s) directly below damaged blade on rear face of thrust ring balancing flange (Ref. fig.402) and secure with nuts and bolts (8).

(b) If moment weight of replacement blade is greater than moment weight of damaged blade, using positional arrangement determined in operation (3), position balancing plate(s) directly opposite (180 degrees) damaged blade on rear face of thrust ring balancing flange (Ref. fig.402) and secure with nut and bolts (8).

NOTE: If a single bolt balancing plate(s) is being fitted ensure it is pushed radially outwards during assembly to ensure a good fit on thrust ring balancing flange.

C D. Remove Damaged Blade (See Method 1 Step C. Page 409)

C E. Install Replacement Blade (See Method 1 Step D. Page 410)

5. Method 3 - Restoration of Assembly Balance using Balancing Weights

C DELETED.

6. Method 4 - Replacement of Complete Set of Blades with another complete set of blades

NOTE: 1. This method details the procedure for replacing a complete set of blades with a complete set of serviceable blades (that have at sometime been sequenced by computer distribution) obtained from a spare L.P. compressor rotor module or spare engine. In this event it is not necessary to effect individual blade balancing.

2. The blade fitted at the L.P. compressor rotor disc number 1 position of the spare module or engine is to be fitted at the rotor disc number 1 position of the installed engine. The remaining replacement blades are to be fitted in numerical sequence (use a felt tip pen to number replacement blades 1 to 33) as arrowed on the L.P. compressor rotor disc of the installed engine.

3. When applying this option, the thrust ring together with the balancing weight(s) is removed (use a felt tip pen to correlate thrust ring position with rotor disc) from the installed engine, the replacement blades fitted and the thrust ring and balance weight(s) re-fitted in the original position on the rotor disc of the installed engine.

4. On completion, in order to confirm that vibration levels are within limits, a vibration survey (Ref. 71-00-00, Adjustment/Test, Test 10) is effected as detailed in this method para.D.15.

R

Referenced Procedures:

| | |
|---|---|
| 71-12-01 | L.H. and R.H. Lower Hinged Cowls - Servicing |
| 71-12-05 | L.H. and R.H. Upper Hinged Cowls - Servicing |
| C 71-00-00 | Power Plant - Adjustment/Test (Test 10) |
| 72-31-03 | L.P. Compressor Spinner and Anti-icing Tubes - Maintenance Practices |
| 72-31-05 | L.P. Compressor Rotor Blades - Inspection/ Check |

Illustrated Parts Catalogue References:

The I.P.C. section where parts disturbed during the following operations can be located is as follows:

| | |
|---|---|
| 72-31-02 | L.P. Compressor Rotor Disc and Blades |
| 72-31-03 | L.P. Compressor Spinner and Anti-icing Tubes |

A. Equipment required:

HU.21567 Retaining ring
Small, clean brush

B. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | B.S.4487: | Mil-T-81533 | 1/21 |
| Dry film lubricant | Electrofilm 77/S | | 4/43E |
| Felt or fibre tip temporary marker | | | 262 |
| Liquid paraffin B.P. | | | 1020 |

C. Remove blade set

NOTE: 1. Reference is made during removal and refitting of blades to number 1 firtree. If this can be established by reference to the correlation marks on the L.P. compressor disc (Fig.402) then blades can be numbered as detailed in operation (2).

2. If the correlation marks are not present or are different to those in Fig.402 they must be ignored and the blades numbered as detailed in operation (3).

(1) Remove any temporary markings on disc front face that may have been left from previous build.

(2) Locate position of No.1 L.P. blade (see Note: 1) as indicated by markings on L.P. disc front face (Ref. Fig.402) and temporary mark the blade No.1, then working anti-clockwise (viewed from front) mark remaining blades 2 to 33).

(3) Alternatively (see Note:2), temporary mark blade at TDC and its corresponding disc position with a number 1, working anti-clockwise mark remaining blade and disc positions 2 to 33 (alternative to operation (2)).

(4) Refer to fig.402 position retaining ring (3) on disc spigot and secure with bolts (4) ensuring gate (5) is in position and secured with knurled nuts (6).

(5) With No.1 blade at T.D.C. pull blade forward until clapper contact prevents further movement. Working anti-clockwise (viewed from front) repeat with each blade, rotating L.P. compressor so that blade being pulled forward is at T.D.C.

(6) Repeat operation (5) until all blades are approximately 0.250in. (6,35 mm.) from ring (5).

(7) Remove knurled nuts (6) and gate (5).

(8) Rotate ring (7) until gap is opposite No.1 blade; withdraw No.1 blade, continue sequence until all blades have been removed.

D. Install replacement blade set.

(1) Prior to installing replacement blades with S.B.72-5540 carry out the following Inspection/ Check:

R (a) Galling

R (i) Up to 0.002in. (0,051 mm.) - Accept.

R (ii) In excess of (i) - Reject.

R (b) Loss of dry film lubricant is acceptable on
R condition that it is re-applied at the next
R convenient opportunity.

(c) The following Fly On limit applies to the blade firtrees:

If there are no suitable replacement blades available, a blade rejected by the above acceptance standards may be re-installed for a maximum period of 125 hours or 25 flights whichever is the sooner.

(1) Refer to Fig.402 apply liquid parafin to replacement blades (platform seals).

(2) With gap in ring (7) opposite the number 1 firtree root in disc. Enter replacement blade marked 1 in disc firtree groove to a depth of approximately 1.0in. (25,4 mm.) ensuring correct positional location by the marking on front face of disc.

(3) Proceeding in a clockwise direction (viewed from the front) enter blade 33 in disc firtree groove. Push blade rearward until clapper contact prevents further movement.

(4) Repeat operation (3) with remainder of blades in order of 32, 31, 30 etc.

(5) Position gate (5) on ring (7) and secure knurled nuts (6).

(6) Continue rearward movement of blades until blade roots are fully entered in disc.

(7) Release bolts (4) and remove retaining ring (3).

(8) CAUTION: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION, AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Using degreasing fluid, clean mating faces of thrust ring (2) to disc spigot and allow to dry.

(9) Brush apply a thin coat of dry film lubricant to mating faces of thrust ring and disc spigot.

(10) Wet assemble thrust ring to disc spigot ensuring correct positional location (Ref. para.2.F) and secure with screws and nuts (3).

NOTE: If difficulty is experienced in fitting the thrust ring to the disc spigot temporarily refit retaining ring, heat thrust ring in an oven to 302 deg.F. (150 deg.C.), repeat operation (7) prior to fitting.

(11) Lubricate blade struts (clappers) (Ref. 72-31-05, Maintenance Practices).

(12) Install L.P. compressor spinner and anti-icing tubes (Ref. 72-31-03).

(13) Engines No.1 and 3

(a) Remove protective work mats or work platform from nose cowl air intake.

(14) Engine No.2

(a) Remove protective work mats from air intake.

(b) Close access doors 431AZ (Ref. 71-12-01) and 433BL (Ref. 71-12-05).

(15) Before next flight carry out a vibration survey as detailed in Test 10 paragraphs A through G. (Ref. 71-00-00, Adjustment/Test) to confirm that vibration level is within limits. If during the vibration survey the broad band (NORM) vibration is outside limits (Ref. 71-00-00, Maintenance Practices) perform paragraph H of Test 10 to establish the individual LOW, MED and HIGH vibration levels.

If high broad band (NORM) vibration is associated with high, 'LOW' band vibration consideration should be given to trim balancing (Ref. 71-00-00, Adjustment/Test, Test No.16) otherwise a full vibration survey to Test 10 (Ref.71-00-00, Adjustment/Test) should be performed.

NOTE: If during the vibration survey the vibration level approaches the limit consideration should be given to trim balancing the engine (Ref. 71-00-00, Adjustment/Test Test No.16).

CR 7. Method 4A - Replacement of Up to Three Blades by Computer
CR Distribution

CR NOTE: 1. Up to three blades may be replaced without regard
CR to moment - weight if the revised set is sequenced
CR by a computer distribution. A computer
CR distribution may be obtained from MCI Scheduling
CR (X-4433) by providing module number and serial
CR numbers of removed blades and replacement blades.

CR 2. The blade fitted at the L.P. compressor rotor disc
CR number 1 position of the spare module or engine is
CR to be fitted at the rotor disc number 1 position of
CR the installed engine. The remaining replacement
CR blades are to be fitted in numerical sequence (use
CR a felt tip pen to number replacement blades 1 to
CR 33) as arrowed on the L.P. compressor rotor disc of
CR the installed engine.

CR 3. When applying this option, the thrust ring together
CR with the balancing weight(s) is removed (use a felt
CR tip pen to correlate thrust ring position with
CR rotor disc) from the installed engine, the
CR replacement blades fitted and the thrust ring and
CR balance weight(s) re-fitted in the original
CR position on the rotor disc of the installed engine.

CR 4. On completion, in order to confirm that vibration
CR levels are within limits, a vibration survey (Ref.
CR 71-00-00, Adjustment/Test, Test 10) is effected as
CR detailed in this method para.D.15.

CR Referenced Procedures:

| | | |
|---|---|---|
| CR | 71-12-01 | L.H. and R.H. Lower Hinged Cowls - Servicing |
| CR | 71-12-05 | L.H. and R.H. Upper Hinged Cowls - Servicing |
| CR | 71-00-00 | Power Plant - Adjustment/Test (Test 10) |
| CR | 72-31-03 | L.P. Compressor Spinner and Anti-icing Tubes - Maintenance Practices |
| CR | 72-31-05 | L.P. Compressor Rotor Blades - Inspection/ Check |

CR Illustrated Parts Catalogue References:

CR The I.P.C. section where parts disturbed during the
CR following operations can be located is as follows:

| | | |
|---|---|---|
| CR | 72-31-02 | L.P. Compressor Rotor Disc and Blades |
| CR | 72-31-03 | L.P. Compressor Spinner and Anti-icing Tubes |

CR A. Equipment required:

CR HU.21567 Retaining ring
CR Small, clean brush

CR B. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | B.S.4487: | Mil-T-81533 | 1/21 |
| Dry film lubricant | Electrofilm 77/S | | 4/43E |
| Felt or fibre tip temporary marker | | | 262 |
| Liquid paraffin B.P. | | | 1020 |

CR C. Remove blade set

CR NOTE: 1. Reference is made during removal and refitting of blades to number 1 firtree. If this can be established by reference to the correlation marks on the L.P. compressor disc (Fig.402) then blades can be numbered as detailed in operation (2).

CR 2. If the correlation marks are not present or are different to those in Fig.402 they must be ignored and the blades numbered as detailed in operation (3).

CR (1) Remove any temporary markings on disc front face that may have been left from previous build.

CR (2) Locate position of No.1 L.P. blade (see Note: 1) as indicated by markings on L.P. disc front face (Ref. Fig.402) and temporary mark the blade No.1, then working anti-clockwise (viewed from front) mark remaining blades 2 to 33).

CR (3) Alternatively (see Note:2), temporary mark blade at TDC and its corresponding disc position with a number 1, working anti-clockwise mark remaining blade and disc positions 2 to 33 (alternative to operation (2)).

CR (4) Refer to fig.402 position retaining ring (3) on disc spigot and secure with bolts (4) ensuring gate (5) is in position and secured with knurled nuts (6).

CR (5) With No.1 blade at T.D.C. pull blade forward until clapper contact prevents further movement. Working anti-clockwise (viewed from front) repeat with each blade, rotating L.P. compressor so that blade being pulled forward is at T.D.C.

CR (6) Repeat operation (5) until all blades are approximately 0.250in. (6,35 mm.) from ring (5).

CR (7) Remove knurled nuts (6) and gate (5).

CR (8) Rotate ring (7) until gap is opposite No.1 blade; withdraw No.1 blade, continue sequence until all blades have been removed.

CR D. Install replacement blade set.

CR (1) Prior to installing replacement blades with S.B.72-5540 carry out the following Inspection/ Check:

CR (a) Dry film lubricant penetration.

CR Inspect the firtree pressure surfaces for evidence of wear and penetration of the dry film lubricant. Penetration will be indicated by a black area on the The normal grey surface finish.

CR (b) The following Fly On limit applies to the
CR blade firtrees:

CR If there are no suitable replacement
CR blades available, a blade rejected by
CR the above acceptance standards may be
CR re-installed for a maximum period of
CR 125 hours or 25 flights whichever is
CR the sooner.

CR (1) Refer to Fig.402 apply liquid parafin to replacement
CR blades (platform seals).

CR (2) With gap in ring (7) opposite the number 1 firtree
CR root in disc. Enter replacement blade marked 1
CR in disc firtree groove to a depth of approximately
CR 1.0in. (25,4 mm.) ensuring correct positional
CR location by the marking on front face of disc.

CR (3) Proceeding in a clockwise direction (viewed from
CR the front) enter blade 33 in disc firtree groove.
CR Push blade rearward until clapper contact prevents
CR further movement.

CR (4) Repeat operation (3) with remainder of blades in
CR order of 32, 31, 30 etc.

CR (5) Position gate (5) on ring (7) and secure knurled
CR nuts (6).

CR (6) Continue rearward movement of blades until blade
CR roots are fully entered in disc.

CR (7) Release bolts (4) and remove retaining ring (3).

CR (8) CAUTION: WHEN USING DEGREASING FLUID, ENSURE
CR ADEQUATE VENTILATION, AVOID SKIN CONTACT
CR AND INHALING THE VAPOUR.
CR Using degreasing fluid, clean mating faces of
CR thrust ring (2) to disc spigot and allow to dry.

CR (9) Brush apply a thin coat of dry film lubricant to
CR mating faces of thrust ring and disc spigot.

CR (10) Wet assemble thrust ring to disc spigot ensuring correct positional location (Ref. para.2.F) and secure with screws and nuts (3).

CR NOTE: If difficulty is experienced in fitting the thrust ring to the disc spigot temporarily refit retaining ring, heat thrust ring in an oven to 302 deg.F. (150 deg.C.), repeat operation (7) prior to fitting.

CR (11) Lubricate blade struts (clappers) (Ref. 72-31-05, Maintenance Practices).

CR (12) Install L.P. compressor spinner and anti-icing tubes (Ref. 72-31-03).

CR (13) Engines No.1 and 3

CR (a) Remove protective work mats or work platform from nose cowl air intake.

CR (14) Engine No.2

CR (a) Remove protective work mats from air intake.

CR (b) Close access doors 431AZ (Ref. 71-12-01) and 433BL (Ref. 71-12-05).

CR (15) Before next flight carry out a vibration survey (Ref. 71-00-00) using FAN switch light to confirm that vibration levels are within limits

CR NOTE: If during the vibration survey the upper permitted vibration levels are approached, it is recommended that a full L.P. Compressor rebalance should be carried out as soon as possible in accordance with Heavy Maintenance Manual, 72-31-02 and overhaul Manual, 72-31-02.

## L.P. COMPRESSOR ROTOR BLADES - INSPECTION/CHECK

R 1. General

R Service Bulletins referred to:

R 71-2213 - Miscellaneous - Minor alterations

R 72-8642 - Engine - L.P. compressor - Restriction of fan blade
R axial clearance

R Referenced Procedures

R 70-42-11 Standard Practices
R 70-00-00 Adjustment/Test
R 72-31-03 Removal/Installation
R 72-31-05 Removal/Installation
R 72-31-05 Approved repairs

2. Inspect L.P. Compressor Rotor Blades

WARNING: FIT HOT AND COLD STREAM OUTLET BLANKS TO PREVENT L.P. COMPRESSOR WINDMILLING.

A. Equipment required:

289200 or C 4G 4342 Protective work mats
or XUT.40959 Nose cowl work platform

B. Preparation inspection and recovery.

(1) No.1 and 3 engines: position work mats or work platform in nose cowl air intake ensuring red warning pennants are clearly visible from aircraft exterior.

(2) No.2 engine: open access panels 433BL and 431AZ and position work mats in air intake ensuring red warning pennants are clearly visible from aircraft exterior.

(3) Enter air intake.

(a) Inspect L.P. compressor rotor blades for:

(i) Surface damage (nicks, dents, cracks and arc burns)

(ii) Bends distortion and blade tip curling

(iii) Blueing/heat discoloration of blade tip

(iv) Axial clearances.

(b) Inspect blade struts (clappers) for:

(i) Surface damage (nicks, dents, cracks, arc burns and deterioration of hard coating and material transfer.

NOTE: An arc-burn is a small circular or semi-circular heat affected area showing dark blue oxide discolouration that may be accompanied by pitting melting or cracking of the blade surface.

For acceptance standards see para.3.

(4) No.1 and 3 engines: remove protective work mats or work platform from air intake.

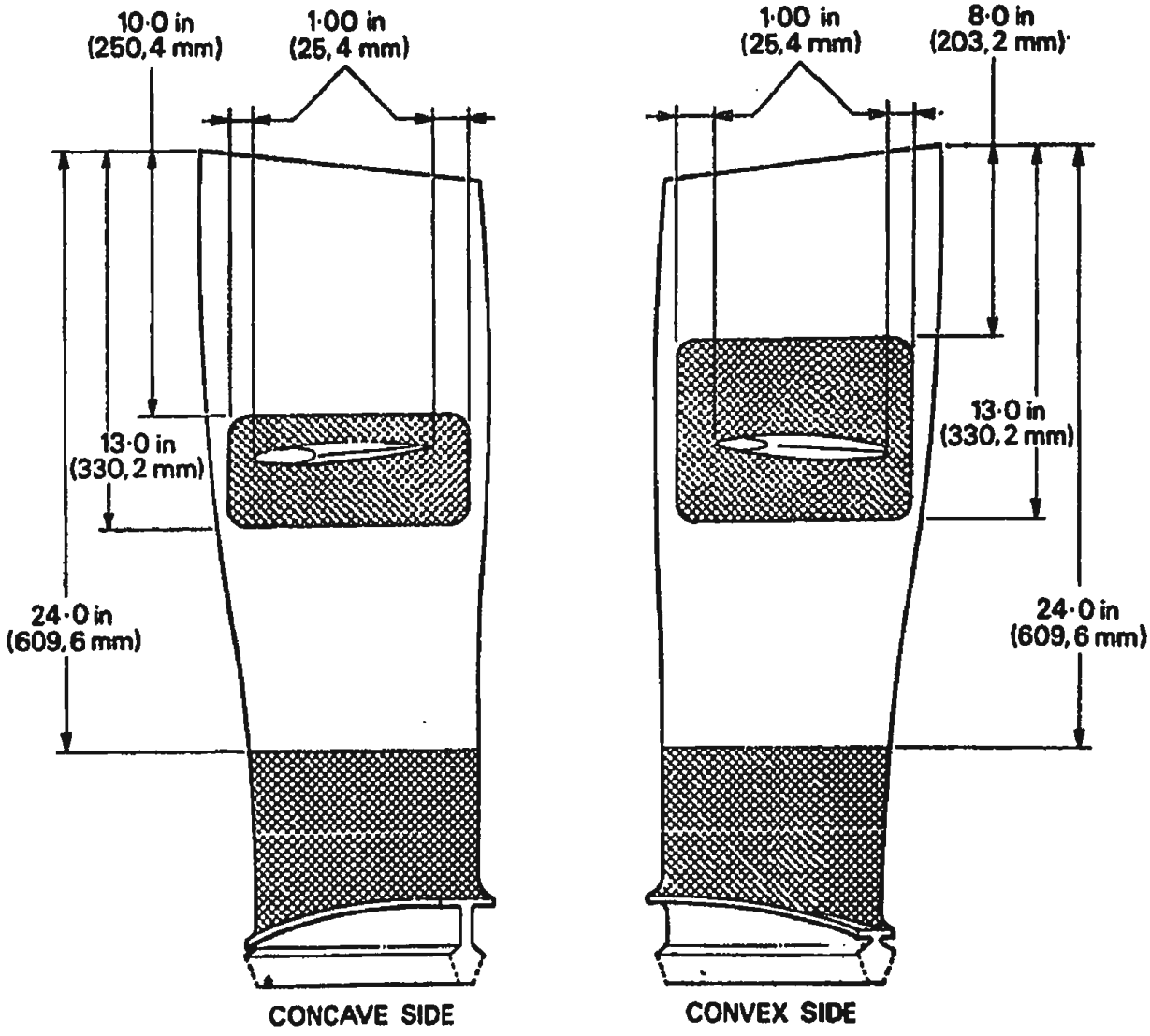
(5) No.2 engine: remove protective work mats from air intake and close access doors 431AZ and 433BL.

3. Acceptance Standards

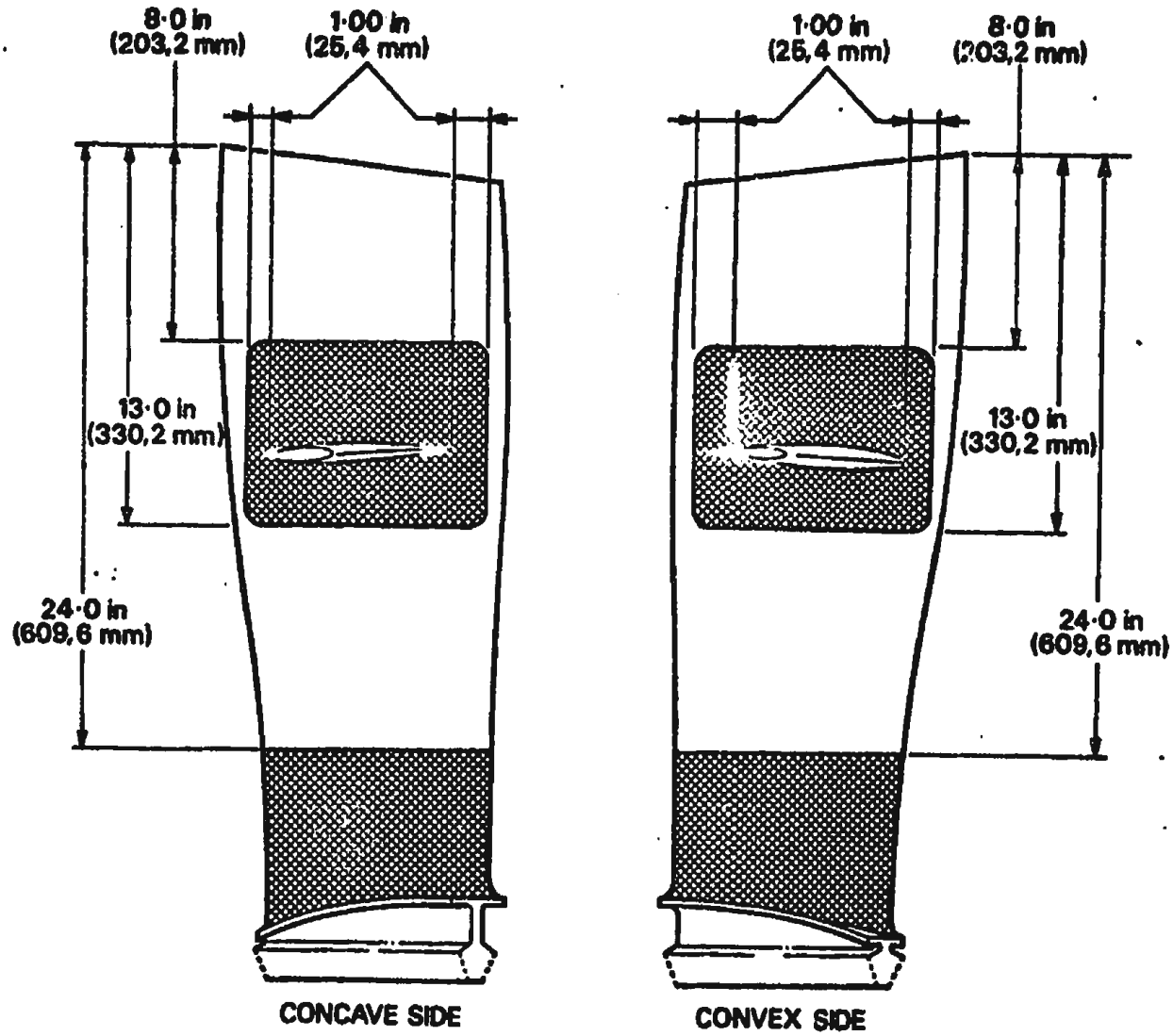
A. Cracks - reject

B. Surface damage

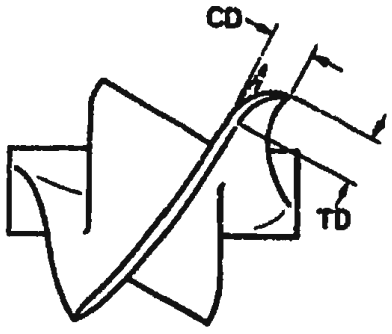
(1) Surface damage on airfoil surfaces, not within critical (shaded) areas (fig.601), may be left undressed if they are not more than 0.008in. (0,203 mm.) in depth. If greater than 0.008in. (0,203 mm.) repair in accordance with FRS.3948 or FRS.3527 (Ref. 72-31-05).



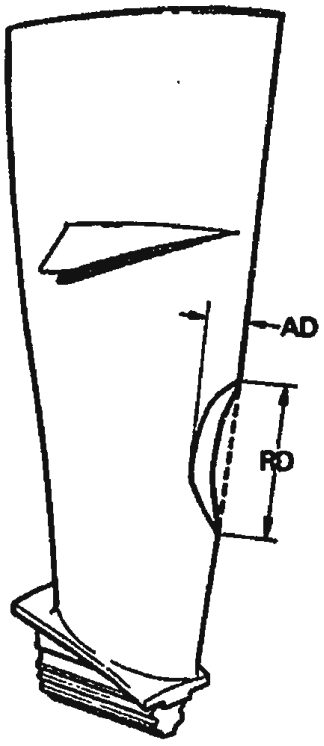

Critical (shaded) areas - Surface damage
Fig.601

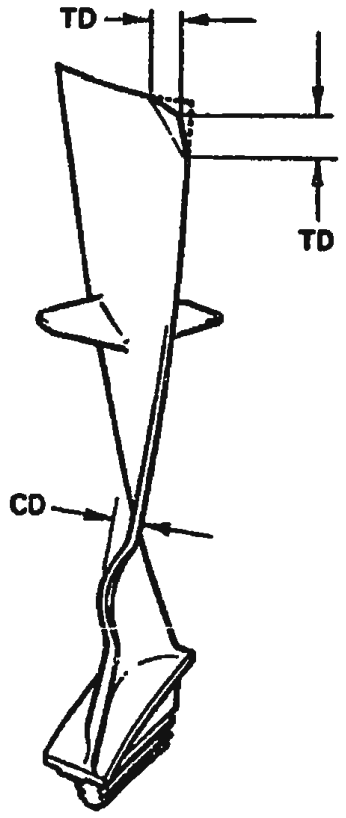



R Critical (shaded) areas - Bent blades
R Fig.602




TIP BEND




EDGE BEND
(APPLICABLE TO LEADING
AND TRAILING EDGE)

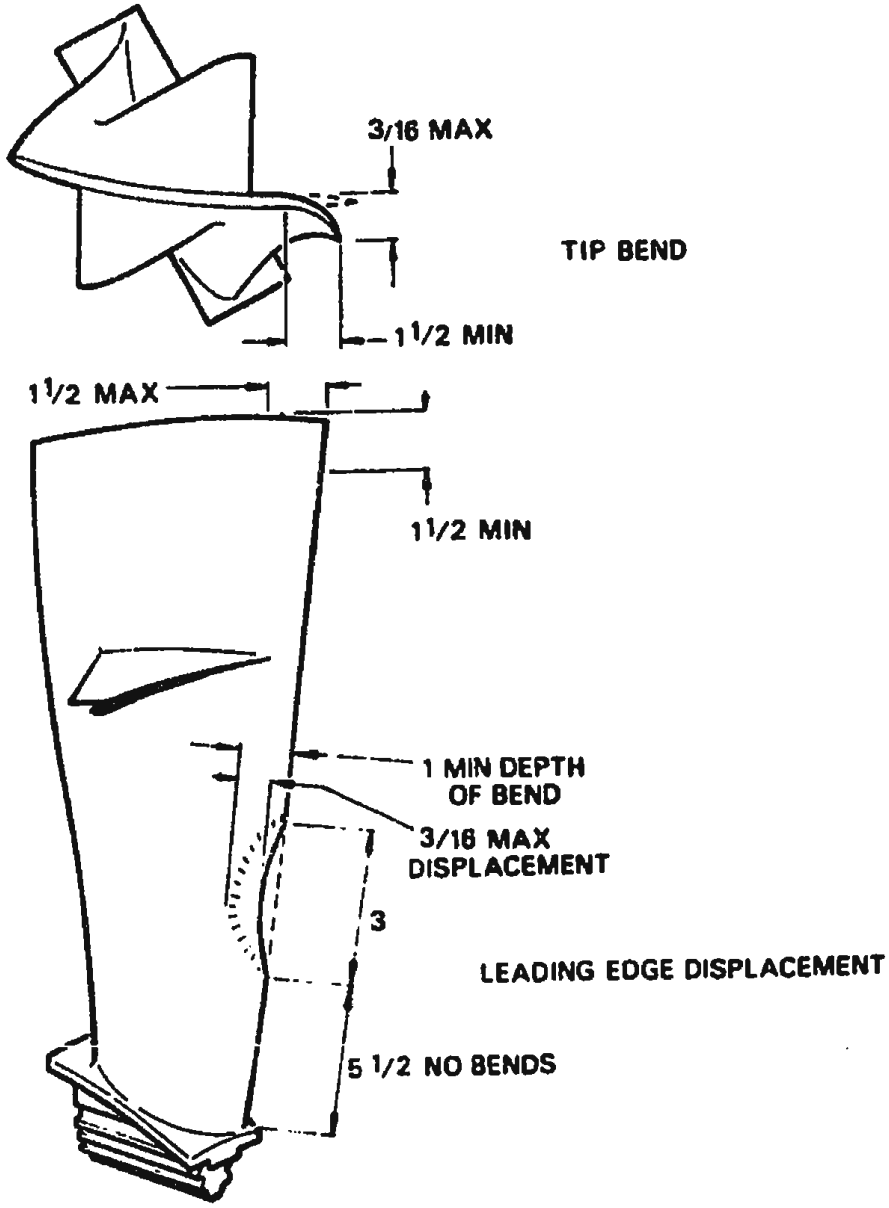
32486A

R L.P. compressor blade distortion definition areas
R Fig.603

R EFFECTIVITY: ALL

R
050B

1A




THIS ILLUSTRATION IS A GUIDE ONLY.
FOR ACTUAL LIMITS SEE MAINTENANCE MANUAL CHAPTER 72-31-05 PAGE 602

49232

CR
CR

RB211 Fan blade bend limits
Fig.603A

EFFECTIVITY: ALL

0508

1A

(2) All surface damage within the critical (shaded) areas (fig.601) must be repaired in accordance with FRS.3948 or FRS.3527 (Ref. 72-31-05).

(3) Blade struts (clappers) upper and lower surfaces and leading and trailing edges:

(a) Nicks up to 0.020in. (0,508 mm.) in depth - Repair to FRS.3253 (Ref. 70-42-11).

(b) Nicks in excess of (a) - Reject

(4) Blade struts (clappers) run out radius:

(a) Nicks up to 0.010in. (0,254 mm.) in depth - Repair to FRS.3253 (Ref. 70-42-11).

(b) Nicks in excess of (a) - Reject

(5) Blade struts (clappers) strut side faces:

(a) Loss or erosion of hard coating around coating edge equivalent to 10 per cent of original provided surrounding coating is smooth and sound and no evidence of detached material having adhered to adjacent face - Accept

(b) Crazed, cracking or pitting provided the coating is smooth and sound - Accept

(c) Unsound coating or beyond limits in (a) and (b) - Reject

NOTE: Inspection of each abutment face must be carried out at top dead centre position with oblique/indirect lighting and mirror in order to observe rear face.

(6) Blueing/heat discoloration of Blade tip

(1) Up to 0.25in. (6,35 mm) of adjacent areofoil surface due to contact with the rotor path - Accept

(2) In excess of (1) - Reject

(7) Fan blade axial clearance check

(a) Remove spinner (Ref.72-31-03).

(b) Tap blades rearward to abut rear retaining plate.

(c) Check fan blade axial clearances

(i) Using feeler gauges check axial clearances between blade and thrust ring

(ii) On engines without S.B.72-8642 if clearances are greater than 0.040in. (1,02mm.) reject fan disc and blade assembly.

(iii) On engines with S.B.72-8642 if clearances are less than 0.002in. (0,051 mm.) reject fan disc and blade assembly.

(iv) On engines with S.B.72-8642 if clearances are greater than 0.012in. (0,305 mm.), pre S.B.72-8642 limits are acceptable, however, the full benefit of S.B.72-8642 will not be obtained.

(4) Pull blades forward to abut thrust ring

(5) Refit spinner (Ref. 72-31-03)

(8) Arc-burns

(a) Evidence of arc-burns - Reject Blade.

NOTE: Blades affected by arc-burns are not repairable and must be scrapped.

(9) Blades damaged beyond maximum repair limits will require replacement (Ref. 72-31-05).

C. Bends

CAUTION: ALL BENDS MUST BE SMOOTH AND FREE FROM KINKS, TEARS, CRACKS AND NICKS. IT IS RECOMMENDED THAT A CRACK TEST IS CARRIED OUT ON BOTH SURFACES OF THE WHOLE BLADE AEROFOIL, AS CRACKING MAY HAVE OCCURED SOME DISTANCE AWAY FROM THE DAMAGED AREA.

Maximum number of bent blades in any one assembly must not exceed three.

Only one bend allowed in any one blade.

Bends must not extend into critical (shaded) areas (Ref. fig.602).

Distortion definitions:

Circumferential distortion is distortion in relation to normal blade contour.
Axial distortion is the distance bend extends into airfoil.
Radial distortion is the distance bend extends along blade edge.

(1) Leading and trailing edge bends (Ref. fig.603).

NOTE: L.P. compressor blades with part number LK45971 (manufactured prior to S.B.71-2213) were produced by the 'two-twist' method. Blades to this standard exhibit a smooth bend in the leading and trailing edges midway between the clapper and root platform, and are acceptable. The following acceptance standards refer to bends that have occurred in service on blades to S.B.71-2213 and subsequent manufacture standards, and to additional bends that have occurred in service on pre S.B.71-2213 blades.

(a) Circumferential distortion (dimension CD) up to a maximum of 0.2in. (5,08 mm.) is acceptable providing axial distortion (dimension AD) is a minimum of 1.00in. (25,4 mm.) and radial distortion (dimension RD) is a minimum of 3.00in. (76,2 mm.).
A maximum of three bent blades with a circumferential distortion (dimension CD) not exceeding 0.50in. (12,7 mm.) are acceptable providing the blades are rejected within 10 hours or 7 flights whichever is the sooner. If this option is exercised, carry out a Vibration Survey (Ref. 71-00-00, Test No.11) to confirm that vibration levels are within limits.

If dimension CD is greater than or less than 0.2in. (5,08 mm.), dimensions AD and RD may be increased or decreased proportionally as appropriate.

Example:

CD = 0.1in. (2,54 mm.)
Therefore AD minimum = 0.5in. (12,7 mm.)
RD minimum = 1.5in. (38,1 mm.)

(b) Associated nicks or cracks can be repaired to FRS.3948 or FRS.3527 (Ref. 72-31-05) providing the bend distortion does not exceed limits given in operation (1)(a).

(c) Blades damaged beyond maximum repair limits will require replacement (Ref. 72-31-05).

(2) Blade tip bends (Ref. fig.603)

(a) Circumferential distortion (dimension CD) is acceptable up to a maximum of 0.2in. (5,08 mm.) providing tip distortion (dimension TD) is a minimum of 1.50in. (38,1 mm.).

If dimension CD is less than 0.2in. (5,08 mm.), dimension TD may be proportionally less.

Example:

CD = 0.1in. (2,54 mm.)
Therefore TD minimum = 0.75in. (19,1 mm.)

(b) Associated nicks or cracks can be repaired to FRS.3948 or FRS.3527 (Ref. 72-31-05) providing the tip distortion does not exceed limits given in operation (2)(a).

(c) Blades damaged beyond maximum repair limits will require replacement (Ref. 72-31-05, Removal/ Installation).

4. Vibration Check After Repair

A. If two blades are dressed to maximum limits it is recommended that a Vibration Survey (Ref. 71-00-00, Test No.11) is carried out using FAN switchlight to confirm that vibration levels are within limits.

B. If vibration level, due to unbalance, is outside limits after blades have been dressed, balancing plates (Ref. 72-31-05) may be fitted to thrust ring adjacent to dressed blades.

C. In selecting a balancing plate (Ref. 72-31-05) it will be necessary to choose one to give the nearest moment weight to the assessed correction required.

NOTE: It is estimated that single blade dressed to maximum limits of FRS.3948 will introduce an unbalance of 12.5 to 15 oz.in. (9000 to 10800 gmm.) in the assembly.

## L.P. COMPRESSOR ROTOR BLADES - CLEANING/PAINTING

Referenced procedures:

71-12-01 Hinged Cowls, LH and RH Lower - Servicing

1. Clean L.P. Compressor Rotor Blades

WARNING: TO PREVENT L.P. COMPRESSOR WINDMILLING, FIT HOT AND COLD STREAM OUTLET BLANKS.

Two methods of cleaning are detailed. Either may be used.

A. Method 1

(1) Equipment required:

| | |
|---|---|
| 289200 | Protective work mats |

(2) Material required:

| | | OMat Item No. |
|---|---|---|
| Cleaning fluid | - | 1070 |
| Demineralized water | | |

(3) On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag appropriate START AIR VALVE circuit breaker.

(4) Tag appropriate ENGINE START panel switchlights.

(5) Engines No.1 and 3

(a) Position work mats in nose cowl air intake ensuring red warning pennants are clearly visible from aircraft exterior.

(6) Engine No.2

(a) Open left-hand hinged cowl 433AL (Ref. 71-12-01, Servicing) and access door 431AZ.

(b) Position work mats in air intake ensuring red warning pennants are clearly visible from aircraft exterior.

R (7) WARNING: WHILST THE WASHING FLUIDS USED IN THE FOLLOWING
R PROCEDURES ARE NON-FLAMMABLE AND NON-TOXIC THEY
R ARE IRRITANTS. PRECAUTIONS SHOULD BE TAKEN IN
R ACCORDANCE WITH WASHING FLUID MANUFACTURERS
R INSTRUCTIONS.

Prepare a solution using a ratio by volume of 4 parts demineralized water to 1 part cleaning fluid. Thoroughly agitate until emulsified

R NOTE: Demineralised water may have a maximum conductance
R of 20 microseimens.

NOTE: If left for more than 30 minutes after mixing, re-agitate mixture.

(8) Enter air intake and wipe blades with clean cloth or soft bristle brush moistened with the mixture.

NOTE: Blade being cleaned must be turned to the 6 o'clock position to prevent ingress of dirt into blade root.

(9) Wipe blades dry with clean cloth.

(10) Engines No.1 and 3

(a) Remove work mats from air intake.

(11) Engine No.2

(a) Remove work mats from air intake.

(b) Close access door 431AZ and left-hand hinged cowl 433AL (Ref. 71-12-01, Servicing).

(12) Remove tags and close circuit breakers opened in operations A. (3) and (4).

B. Method 2

(1) Equipment required:

289200 Protective work mats

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid (inhibited and stabilized 1.1.1 trichloroethane) | BS.4487: 1969 | Mil-T-81533 | 1/21 |

(3) Effect operations A (3), (4), (5) and (6).

WARNING: 1. WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.

2. SMOKING MUST NOT BE ALLOWED WHEN USING DEGREASING FLUIDS AS THE VAPOUR DECOMPOSES TO FORM PRODUCTS WHICH ARE EXTREMELY TOXIC.

(4) Wipe blades with clean cloth moistened with degreasing fluid.

NOTE: Blade being cleaned must be turned to the 6 o'clock position to prevent ingress of dirt into blade root.

(5) Effect operations A. (10), (11) and (12).

## L.P. COMPRESSOR BLADES - APPROVED REPAIRS

### LIST OF REPAIRS


| | Repair No. | Title | Page No. |
|---|---|---|---|
| R R | FRS.3527 | L.P. compressor blades - Repair airfoil damage by dressing | 802 |
| R | FRS.3948 | L.P. compressor blades - Repair airfoil damage by dressing (simplified method) | 814 |
| R | FRS.4378 | L.P. compressor blades - Leading edge tip cropping - Fly back limits only | 827 |

R LOW PRESSURE (L.P.) COMPRESSOR BLADES -

R REPAIR AIRFOIL DAMAGE BY DRESSING

FRS.3527

R 1. Effectivity

| | I.P.C. Fig./Item | Part No. | | |
|---|---|---|---|---|
| R | 01 280 | LK45971 | | |
| R | | LK48141 | S.B.71-2213 | Item L |
| R | | LK50398 | S.B.72-2314 | Part 1 |
| R | | LK50397 | S.B.72-2314 | Part 2 |
| R | | LK54465 | S.B.72-2825 | Part 1 |
| R | | LK54466 | S.B.72-2825 | Part 2 |
| R | | LK57062 | S.B.72-3213 | Part 1 |
| R | | LK57063 | S.B.72-3213 | Part 2 |
| R | | LK57064 | S.B.72-3213 | Part 3 |
| R | | LK57065 | S.B.72-3213 | Part 4 |
| R | | LK57083 | S.B.70-3213 | Part 5 |
| R | | LK77455 | S.B.72-5434 | Part 1 |
| R | | LK77452 | S.B.72-5434 | Part 2 |
| R | | LK81128 | S.B.72-5540 | Part 1 |
| R | | LK81129 | S.B.72-5540 | Part 1 |
| R | | LK81130 | S.B.72-5540 | Part 1 |
| R | | LK78956 | S.B.82-5540 | Part 1 |
| R | | LK75906 | S.B.72-5540 | Part 1 |
| R | | LK78958 | S.B.72-5540 | Part 2 |
| R | | LK79001 | S.B.72-5540 | Part 2 |
| R | | LK79002 | S.B.72-5540 | Part 2 |
| R | | LK79003 | S.B.72-5540 | Part 2 |
| R | | LK79004 | S.B.72-5540 | Part 2 |
| R | | LK79005 | S.B.72-5540 | Part 2 |
| R | | LK77517 | S.B.72-5540 | Part 2 |
| R | | LK81091 | S.B.72-5540 | Part 3 |
| R | | LK81084 | S.B.72-5540 | Part 3 |
| R | | LK81085 | S.B.72-5540 | Part 3 |
| R | | LK81086 | S.B.72-5540 | Part 3 |
| R | | LK81087 | S.B.72-5540 | Part 3 |
| R | | LK81088 | S.B.72-5540 | Part 3 |
| R | | LK81089 | S.B.72-5540 | Part 3 |

| | | | |
|---|---|---|---|
| R | UL19591 | S.B.72-7895 | Part 3 |
| R | UL19592 | S.B.72-7895 | Part 3 |
| R | UL19593 | S.B.72-7895 | Part 3 |
| R | UL19594 | S.B.72-7895 | Part 3 |
| R | UL19595 | S.B.72-7895 | Part 3 |
| R | UL19596 | S.B.72-7895 | Part 3 |
| R | UL19597 | S.B.72-7895 | Part 3 |
| R | UL19598 | S.B.72-7895 | Part 3 |
| R | UL19599 | S.B.72-7895 | Part 3 |
| R | UL19600 | S.B.72-7895 | Part 3 |
| R | UL19601 | S.B.72-7895 | Part 3 |
| R | UL19602 | S.B.72-7895 | Part 3 |
| R | UL19641 | S.B.72-7895 | Part 3 |
| R | LK86362 | S.B.72-7895 | Part 3 |
| R | LK86356 | S.B.72-7895 | Part 3 |
| R | LK86357 | S.B.72-7896 | Part 3 |
| R | LK86358 | S.B.72-7895 | Part 3 |
| R | LK86359 | S.B.72-7895 | Part 3 |
| R | LK86360 | S.B.72-7895 | Part 3 |
| R | LK86361 | S.B.72-7895 | Part 3 |
| R | UL19609 | S.B.72-7906 | Part 3 |
| R | UL19610 | S.B.72-7906 | Part 3 |
| R | UL19611 | S.B.72-7906 | Part 3 |
| R | UL19612 | S.B.72-7906 | Part 3 |
| R | UL19613 | S.B.72-7906 | Part 3 |
| R | UL19614 | S.B.72-7906 | Part 3 |
| R | UL19615 | S.B.72-7906 | Part 3 |
| R | UL19616 | S.B.72-7906 | Part 3 |
| R | UL19617 | S.B.72-7906 | Part 3 |
| R | UL19618 | S.B.72-7906 | Part 3 |
| R | UL19619 | S.B.72-7906 | Part 3 |
| R | UL19620 | S.B.72-7906 | Part 3 |
| R | UL19621 | S.B.72-7906 | Part 3 |
| R | UL19622 | S.B.72-7906 | Part 3 |
| R | UL19623 | S.B.72-7906 | Part 3 |
| R | UL19624 | S.B.72-7906 | Part 3 |
| R | UL19625 | S.B.72-7906 | Part 3 |
| R | UL19626 | S.B.72-7906 | Part 3 |
| R | UL19627 | S.B.72-7906 | Part 3 |
| R | UL19642 | S.B.72-7906 | Part 3 |

R 2. Instructions

R Dressing of fan blades will affect engine performance and balance. The extent of dressing must be limited accordingly.

R As a rough guide, the maximum amount of material which may be removed from a given fan assembly is the equivalent of two blades dressed to the maximum limits, the remaining blades being undressed.

R Any combination of scalloping cropping and dressing may be applied to a given blade provided that the maximum limitation for any one of these is not exceeded by the combination.

R Dressing may be accomplished using grinding wheels or mechanised cutters. If grinding wheels are used they must be silicon carbide type and NOT aluminium oxide type.

R This Repair has two parts as follows:

R A. Repair the damage:

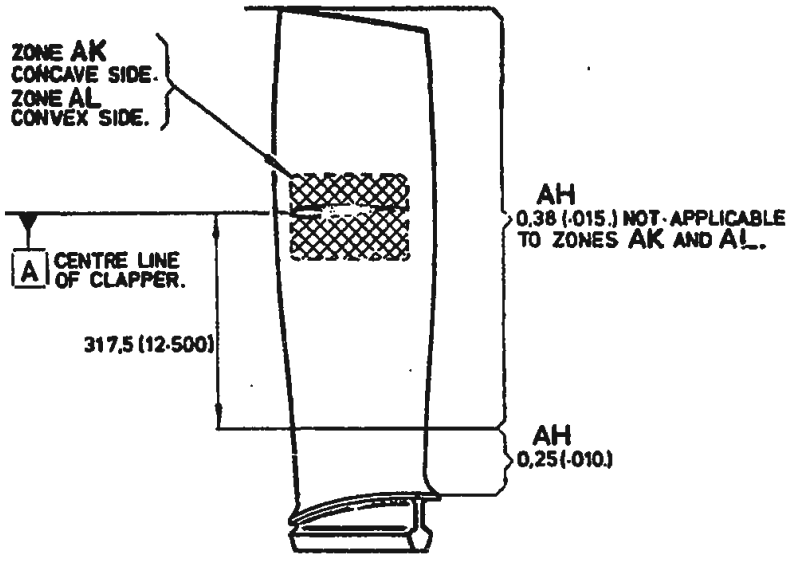
R This part covers the application of dressing, cropping and scalloping techniques.

R B. Restore leading edge radius:

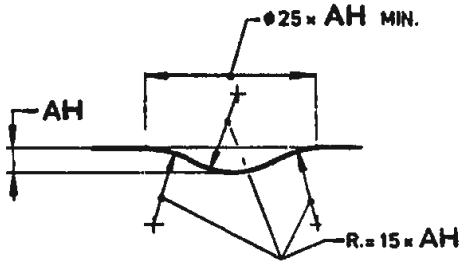
R This part covers the removal of flats from the long side of the blade.

R A. Repair the damage

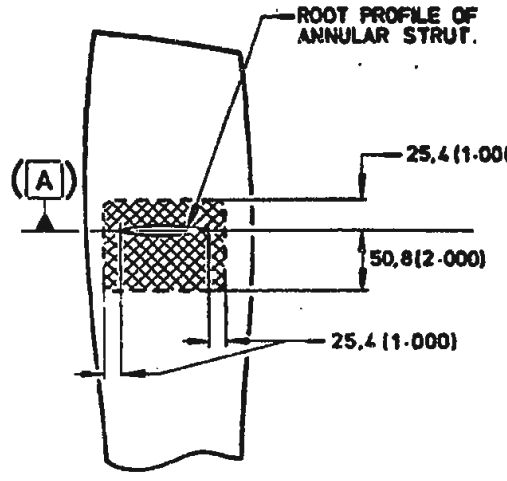
| R | Procedure | Supplementary Information |
|---|---|---|
| R | (1) Penetrant crack test to determine full extent of damage | T.S.D.594, O.P.210 |
| R | (2) Dress to remove damage. | See fig.801 for surface dressing<br>See fig.802 for scalloping<br>See fig.803 for tip cropping<br>Light cuts only may be made if using mechanical cutters to prevent overheating of material. Dressing must be continued until all suspect material is removed. |



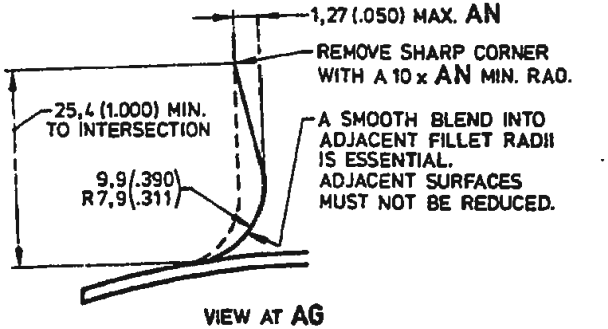

DRESSING OF SURFACE DAMAGE.



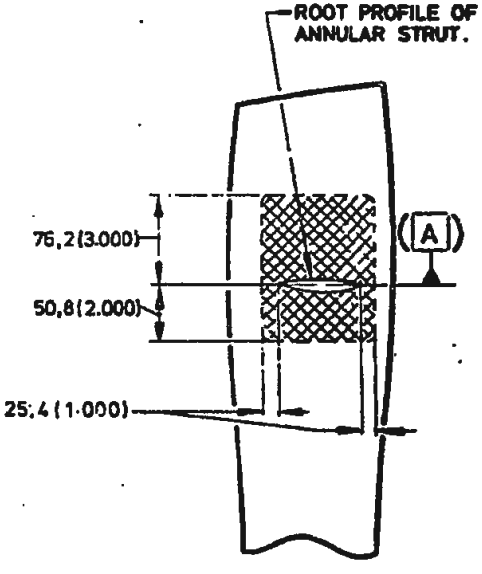

NOTE:- AH IS MAX. DEPTH OF DRESSING.




SHOWING EXTENT OF DRESSING ZONE AK (CONCAVE SURFACE). MAX. DEPTH OF DRESSING WITHIN THIS ZONE TO BE 0,25 (·010).




VIEW AT AG
SHOWING DRESSING AT L.E.
ROOT FILLET RADIUS.




SHOWING EXTENT OF DRESSING ZONE AL (CONVEX SURFACE). MAX. DEPTH DRESSING WITHIN THIS ZONE TO BE 0,25 (·010)

37481A

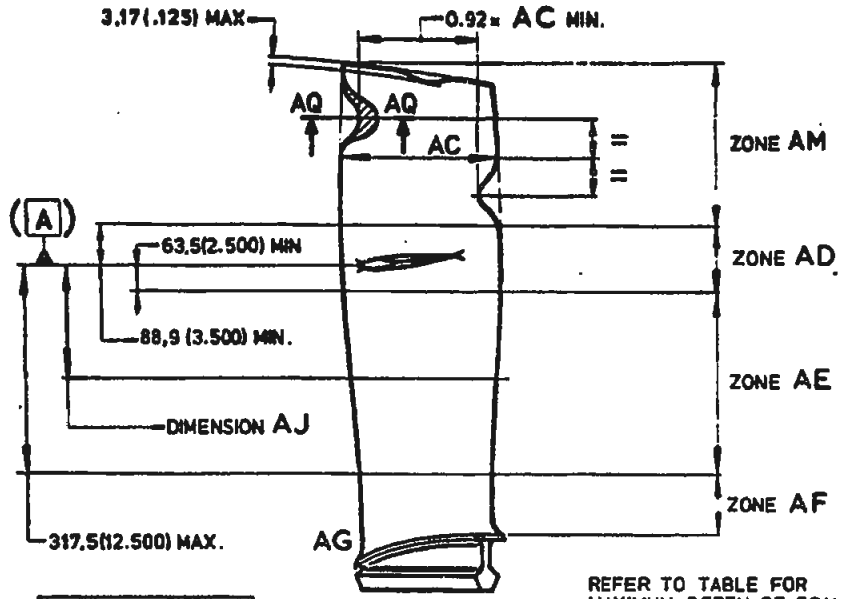
R
R

Dressing Limits
Fig.801

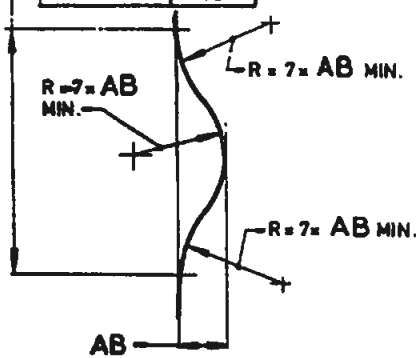
EFFECTIVITY: ALL

050B

1A

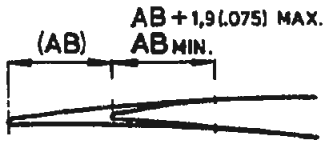



| MIN LENGTH | ZONE |
|---|---|
| 20 × AB | AD |
| 10 × AB | AE.AF |




SHOWING SCALLOP PROPORTIONS.

REFER TO TABLE FOR MAXIMUM DEPTH OF SCALLOPS WITHIN ZONES SPECIFIED ABOVE.




SECTION AQ SHOWING REQUIRED BLEND AREA. MIN. ACCEPTABLE RADIUS ON LEADING OR TRAILING EDGE AT ANY POSITION TO BE R0,711 (.028). WHERE CROSS SECTIONAL THICKNESS IS BELOW 1,422(.056) AND WITHIN ACCEPTANCE LIMITS QUOTED IN INSPECTION/CHECK THE RADIUS SHOULD BE HALF THE CROSS SECTIONAL THICKNESS.

NOTE:-
LENGTH OF LEADING EDGE
= 805,18 (31.700) APPROX.

| ZONE | DIMENSION AJ | SCALLOP DEPTH MAX.(AB) | REMARKS |
|---|---|---|---|
| AD | N.A. | 3,8 (.150) | ONE (1) SCALLOP ONLY IS PERMITTED ON LEADING AND/OR TRAILING EDGES. SCALLOPS MUST NOT BE COINCIDENT RADIALLY. |
| AE | 63,50 (2.500) | 7,93 (.312) | ONE (1) SCALLOP ONLY IS PERMITTED WITHIN THIS ZONE. |
| | 101,60 (4.000) | 6,83 (.269) | |
| | 152,40 (6.000) | 6,10 (.240) | |
| | 203,20 (8.000) | 5,33 (.210) | |
| | 254,00 (10.000) | 4,65 (.183) | |
| | 304,80 (12.000) | 3,88 (.153) | |
| | 317,50 (12.500) | 3,20 (.126) | |
| AF | N.A. | 1,90 (.075) | ONE (1) SCALLOP ONLY IS PERMITTED ON LEADING AND/OR TRAILING EDGES. SCALLOPS MUST NOT BE COINCIDENT RADIALLY. |
| AM | N.A. | 9,53 (.375) | TWO (2) SCALLOPS ONLY ARE PERMITTED ON LEADING AND/OR TRAILING EDGES, PROVIDED THAT ALL OTHER CONDITIONS ARE MET. |

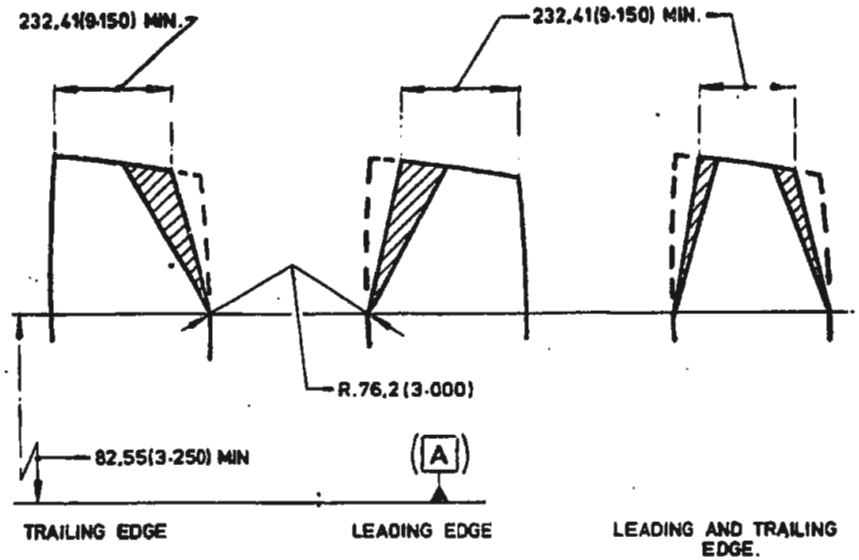
TYPICAL BLENDING AREA.

SCALLOPING AND CROPPING BLENDING PROPORTIONS.

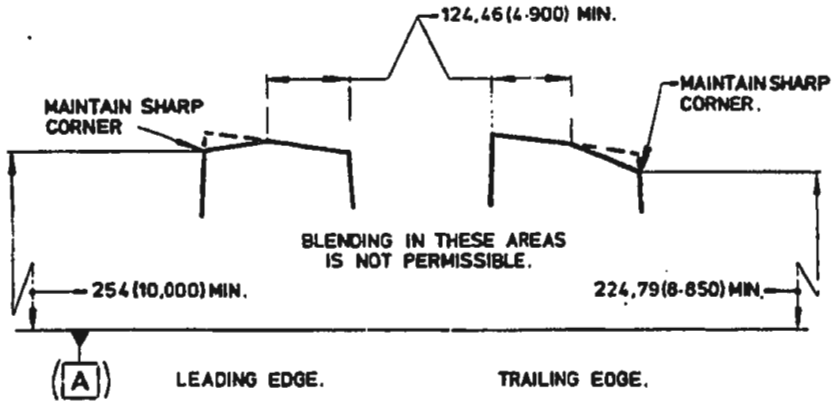
37452B

R
R
Scalloping limits
Fig.802

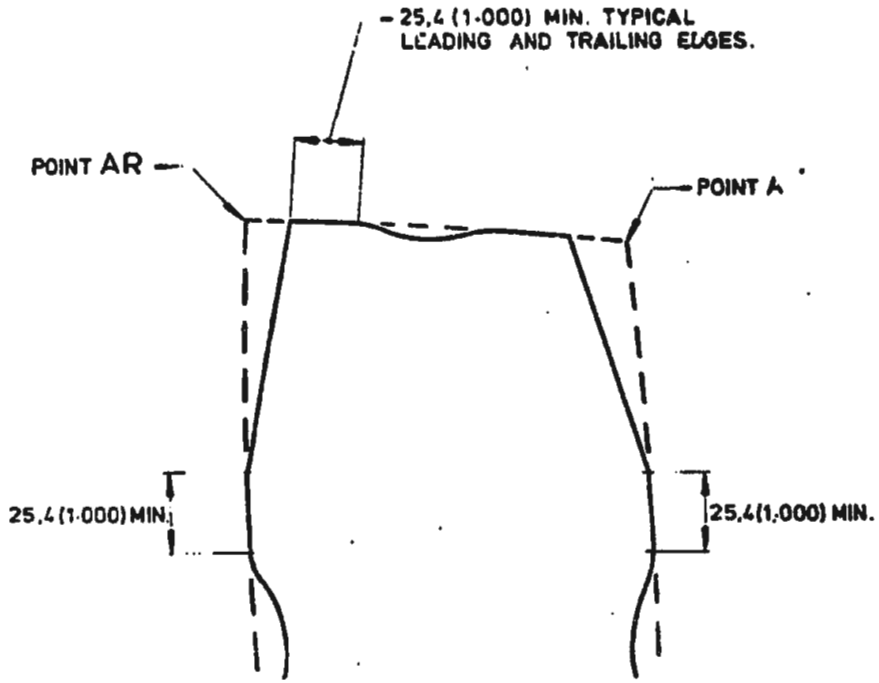
R EFFECTIVITY: ALL
R
050B 1A




LEADING AND TRAILING EDGE CROPPING.




TIP CROPPING.

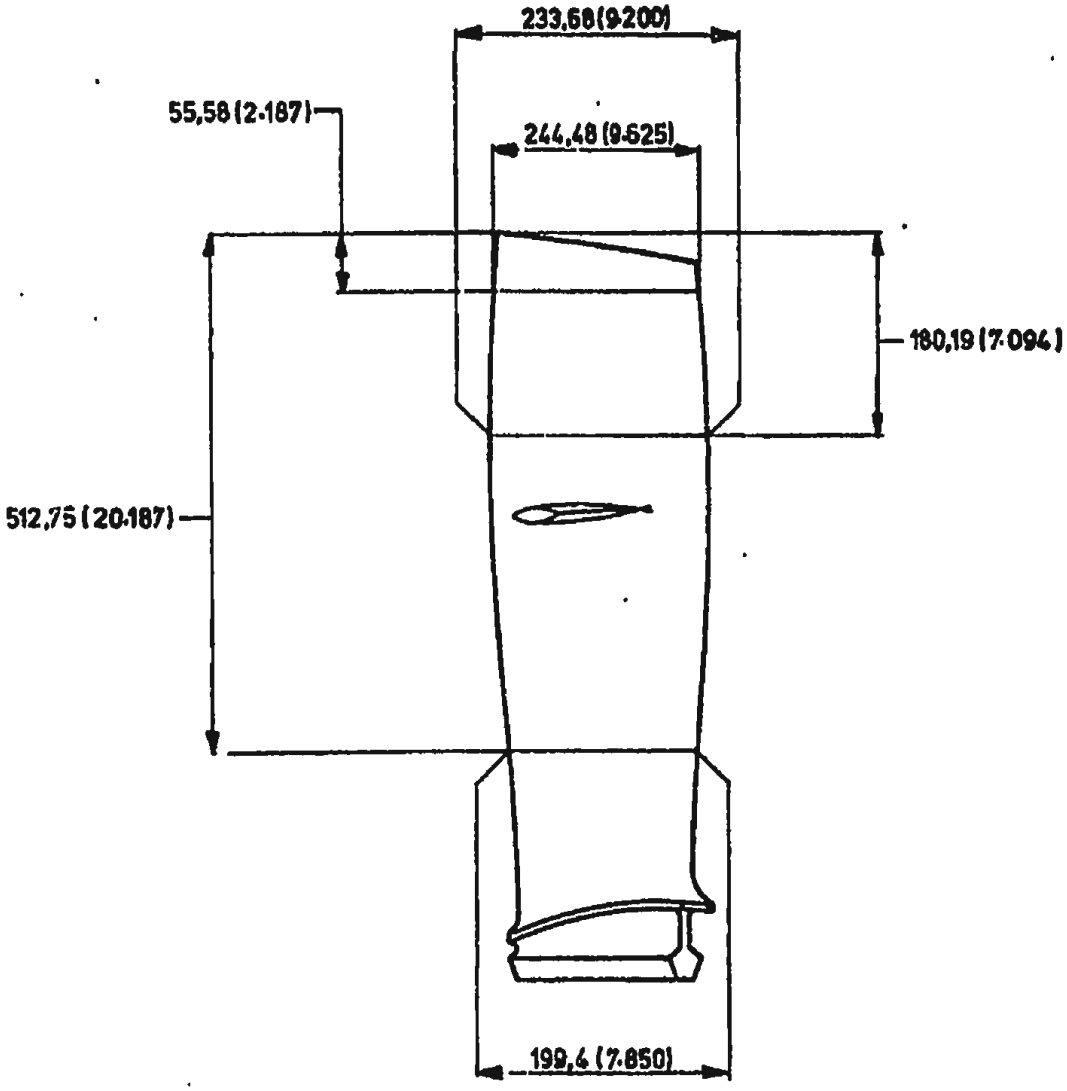



NOTE:-
THE MINIMUM DIMENSIONS QUOTED APPLY TO ANY COMBINATION OF CROPPING AND SCALLOPING IN THE BLADE TIP AREA.
IF TIP CROPPING HAS NOT BEEN CARRIED OUT, THESE DIMENSIONS APPLY FROM THE BLADE TIP POINTS AR AND AP.

SHOWING MINIMUM ACCEPTABLE CONDITIONS BETWEEN TIP CROPPING AND SCALLOPING.

37483

R Minimum acceptable conditions between cropping and scalloping
R Fig.803




MINIMUM CHORDAL WIDTH AFTER DRESSING

44238

R Minimum chordal width after dressing
R Fig.804

| | Procedure | Supplementary Information |
|---|---|---|
| R (3) | Blend the dressed areas and polish out dressing scores | See fig.801, 802 and/or 803 for blending limits. Any polish or dressing marks must run in radial direction (i.e. from root to tip of blade) |
| R (4) | Visually and dimensionally inspect<br>Check surface finish | See fig.801, 802 and/or 803 |
| R (5) | Swab etch dressed area | T.S.D.594, O.P.133<br>Solution 2 Hydrofluoric acid/nitric acid etchant. Etching time 20 seconds maximum.<br>Observe safety precautions. |
| R (6) | Penetrant crack test | T.S.D.594, O.P.210 |
| R (7) | Wet abrasive blast the repair area using 120/220 grade aluminium oxide | T.S.D.594, O.P.104<br>Blades repaired on installed engines MUST be blasted at next shop visit. |
| R (8) | Vibro-engrave FRS.3527A on blade root front face | |

R B. Restore leading edge radius

| | Procedure | Supplementary Information |
|---|---|---|
| R (1) | Restore radius | See fig.802, polish or dress to remove sharp corners and rough surface finish.<br>Remove minimum material |

| | Procedure | Supplementary Information |
|---|---|---|
| R (2) | Visually and dimensionally inspect | See fig.802 and 804, check minimum chordal width at 3 places |
| R (3) | Penetrant crack test | T.S.D.594, O.P.210 |
| R (4) | Wet abrasive blast | T.S.D.594, O.P.104. Use 120-220 grade aluminium oxide OMat 146, Blast zone 6,35 to 19,05 mm. (0.25 to 0.75in.) wide each side of leading edge |
| R (5) | Vibro-engrave FRS.3527B on blade root front face | |

R 3. Material of component

| Description | R.R. Symbol | Material |
|---|---|---|
| L.P. Compressor Blade | TBQ | Titanium alloy |

R 4. Tools

Special tools are not required.

R 5. Parts required

Not applicable

R 6. Price and availability

Repair of spares - Refer to Rolls-Royce Limited

# L.P. COMPRESSOR BLADES - REPAIR AIRFOIL DAMAGE BY DRESSING (SIMPLIFIED METHOD)

## FRS.3948

## 1. Effectivity

| I.P.C. Fig./Item | Part No. | | |
|---|---|---|---|
| 01 280 | LK45971 | | |
| | LK48141 | S.B.71-2213 | Item L |
| | LK50398 | S.B.72-2314 | Part 1 |
| | LK50397 | S.B.72-2314 | Part 2 |
| | LK54465 | S.B.72-2825 | Part 1 |
| | LK54466 | S.B.72-2825 | Part 2 |
| | LK57062 | S.B.72-3213 | Part 1 |
| | LK57063 | S.B.72-3213 | Part 2 |
| | LK57064 | S.B.72-3213 | Part 3 |
| | LK57065 | S.B.72-3213 | Part 4 |
| | LK57083 | S.B.72-3213 | Part 5 |

## 2. General

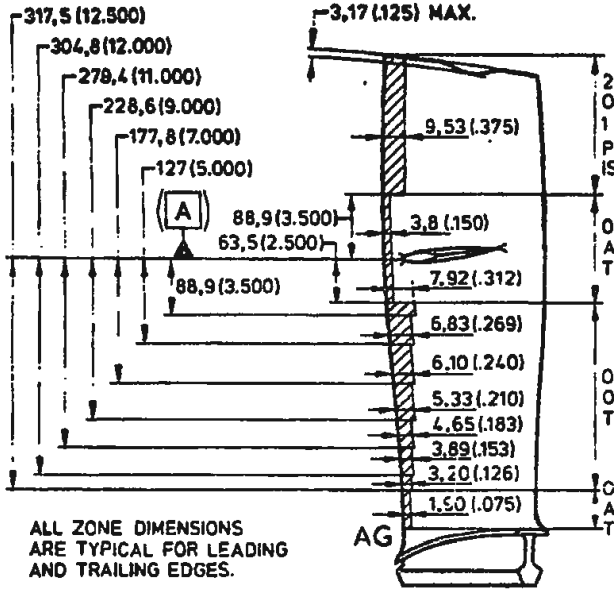
The dressing in this Repair is a simplified version of that in FRS.3527 and slightly limits amount of dressing allowed.

For full allowable limits refer to FRS.3527. Repair airfoil damage by dressing.

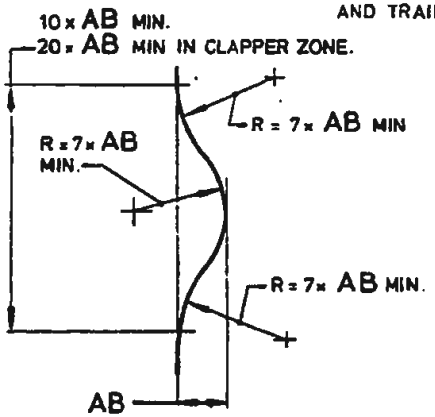
## 3. Instructions

Dressing of fan blades will affect engine performance and balance. The extent of dressing must be limited accordingly.

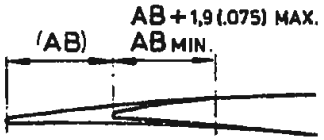
As a rough guide, the maximum amount of material which may be removed from a given fan assembly is the equivalent of three blades dressed to the maximum limits, the remaining blades being undressed.


317,5 (12.500)
304,8 (12.000)
279,4 (11.000)
228,6 (9.000)
177,8 (7.000)
127 (5.000)
A
88,9 (3.500)
63,5 (2.500)
88,9 (3.500)
3,17 (.125) MAX.
9,53 (.375)
3,8 (.150)
7,92 (.312)
6,83 (.269)
6,10 (.240)
5,33 (.210)
4,65 (.183)
3,89 (.153)
3,20 (.126)
1,90 (.075)
AG
2 MAX. DEPTH SCALLOPS PERMITTED ON LEADING EDGE OR TRAILING EDGE. 1 SCALLOP PERMITTED ON BOTH EDGES PROVIDED MINIMUM CHORD 0.92 x AC IS MAINTAINED.
ONE SCALLOP ON LEADING EDGE AND TRAILING EDGE, PROVIDED THEY ARE NOT RADIALLY COINCIDENT.
ONE SCALLOP PERMITTED ON LEADING EDGE OR TRAILING EDGE.
ONE SCALLOP ON LEADING EDGE AND TRAILING EDGE, PROVIDED THEY ARE NOT RADIALLY COINCIDENT.
ALL ZONE DIMENSIONS ARE TYPICAL FOR LEADING AND TRAILING EDGES.
DIMENSIONS QUOTED REPRESENT MAX. SCALLOP DEPTH WITHIN THE SHADED ZONE.

SCALLOPING OF LEADING AND TRAILING EDGES.




SHOWING SCALLOP PROPORTIONS

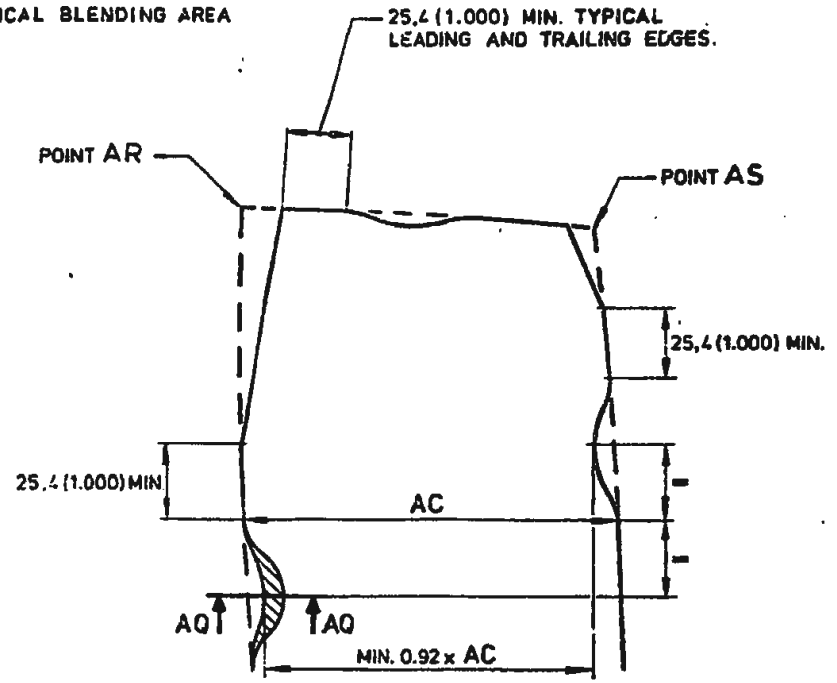



SECTION AQ SHOWING REQUIRED BLEND AREA.

NOTE:-
LENGTH OF LEADING EDGE
= 805,18 (31.700) APPROX

SCALLOPING AND CROPPING BLENDING PROPORTIONS.

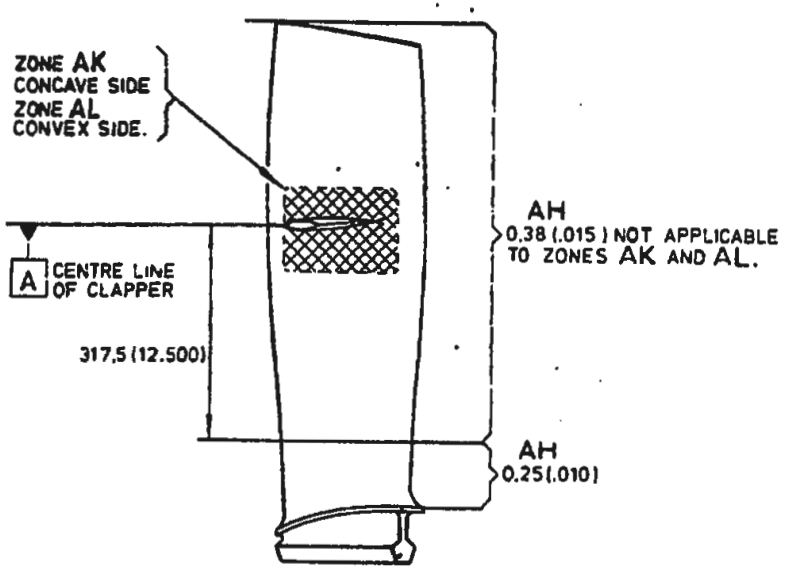
TYPICAL BLENDING AREA



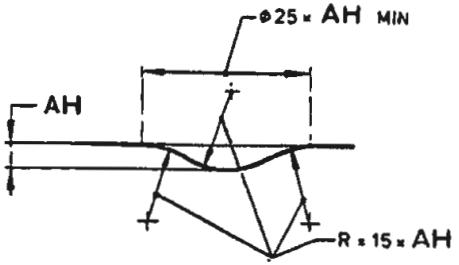

NOTE -
THE MINIMUM DIMENSIONS QUOTED APPLY TO ANY COMBINATION OF CROPPING AND SCALLOPING IN THE BLADE TIP AREA.
IF TIP CROPPING HAS NOT BEEN CARRIED OUT, THESE DIMENSIONS APPLY FROM THE BLADE TIP POINTS AR AND AS.

SHOWING MINIMUM ACCEPTABLE CONDITIONS BETWEEN LEADING EDGE AND TRAILING EDGE SCALLOPING AND/OR TIP CROPPING..

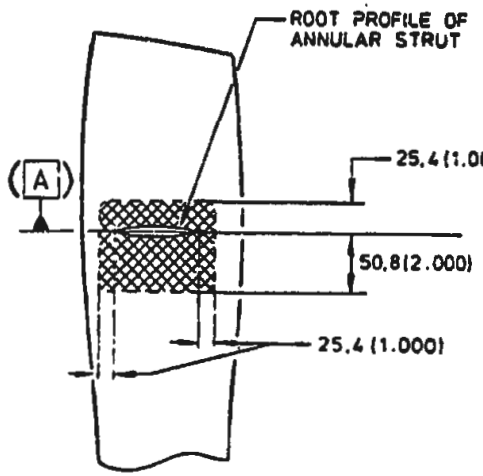
41233 D



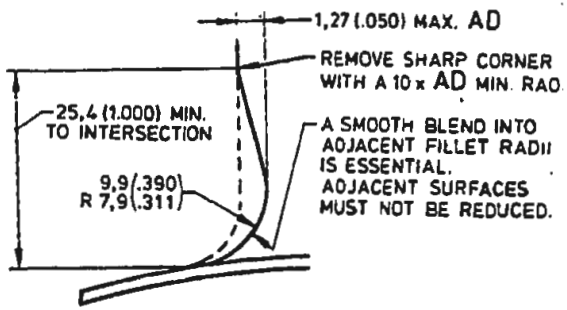

DRESSING OF SURFACE DAMAGE



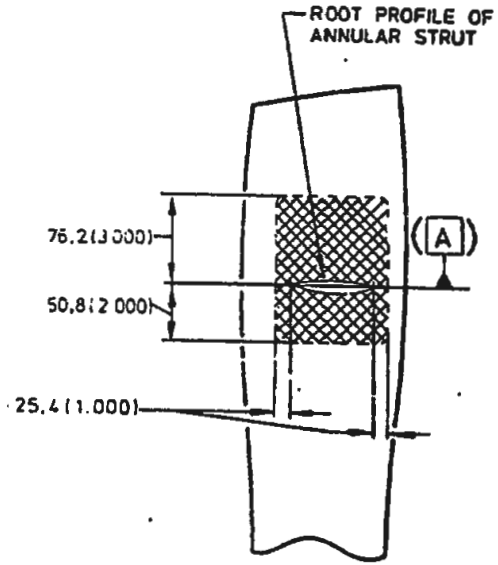

NOTE:- AH IS MAX DEPTH OF DRESSING




SHOWING EXTENT OF DRESSING ZONE AK (CONCAVE SURFACE) MAX DEPTH OF DRESSING WITHIN THIS ZONE TO BE 0,25(.010)

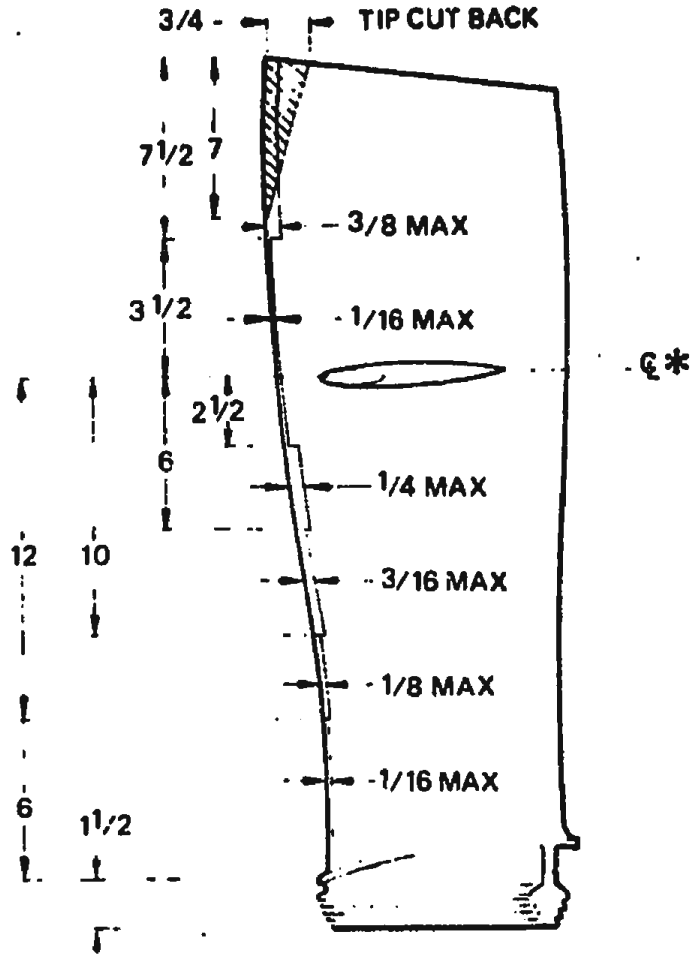

1,27 (.050) MAX. AD
REMOVE SHARP CORNER WITH A 10 x AD MIN. RAD
25,4 (1.000) MIN. TO INTERSECTION
9,9 (.390)
R 7,9 (.311)
A SMOOTH BLEND INTO ADJACENT FILLET RADII IS ESSENTIAL. ADJACENT SURFACES MUST NOT BE REDUCED.

VIEW AT AG
SHOWING DRESSING AT L.E. ROOT FILLET RADIUS.




SHOWING EXTENT OF DRESSING ZONE AL (CONVEX SURFACE) MAX. DEPTH DRESSING WITHIN THIS ZONE TO BE 0.25 (.010)

41250A



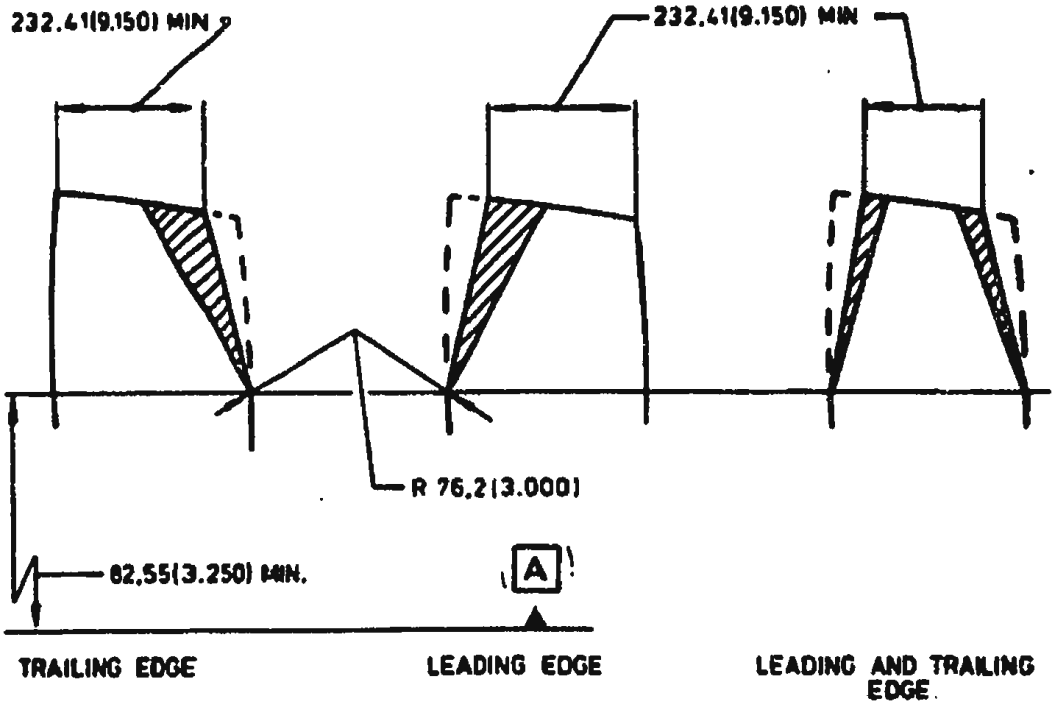

NOTES

*ESTIMATE CENTRE LINE OF CLAPPER
ALL DIMENSIONS ARE IN INCHES
DRESSED OUT AREA MUST BE 10 TIMES AS LONG AS IT IS DEEP.
SEE MM FOR MORE THAN 1 DRESSED OUT AREA PER BLADE.

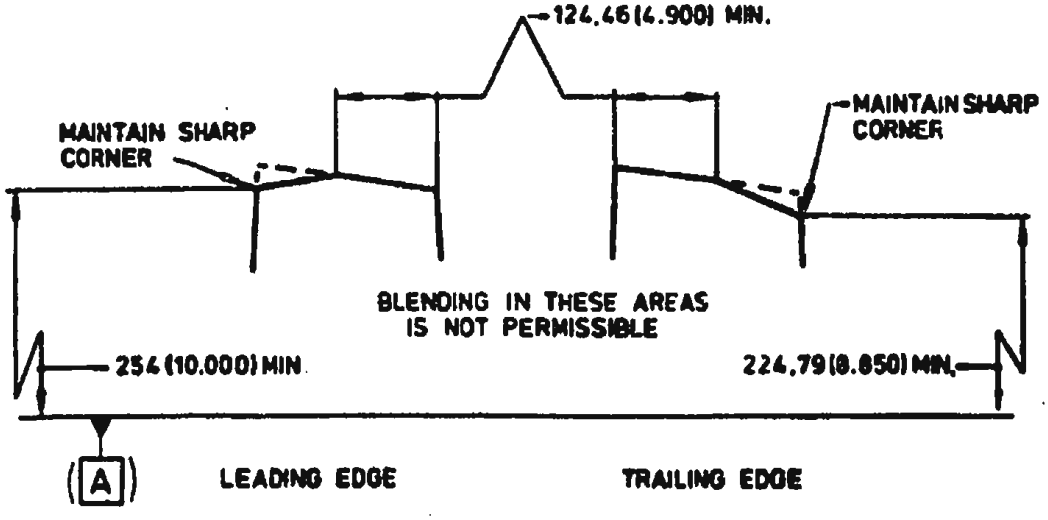
THIS ILLUSTRATION IS A GUIDE ONLY.
FOR ACTUAL LIMITS SEE MAINTENANCE MANUAL
CHAPTER 72 31-05 PAGE 805/806

49231

C RB211 Fan blade dress out and leading edge tip cut back limits
C Fig.806A



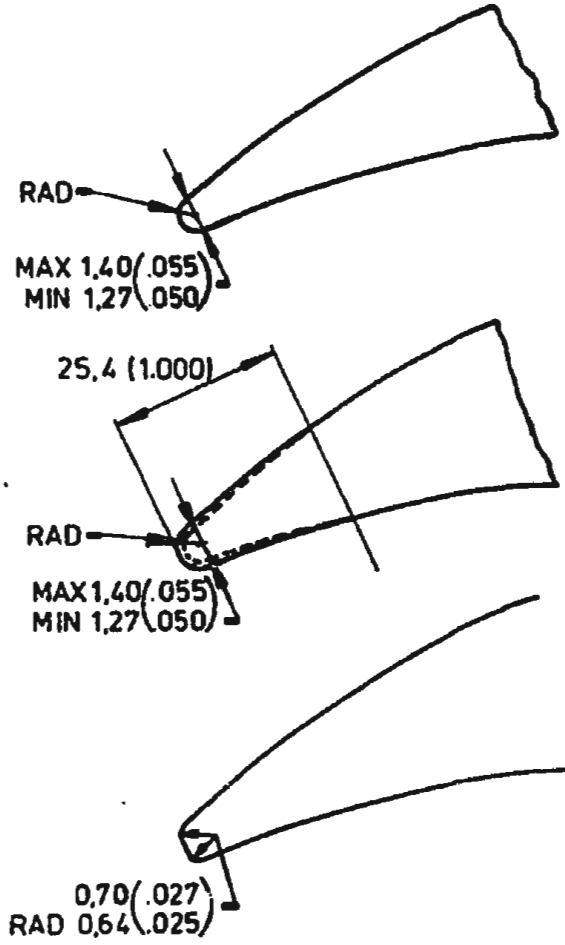

LEADING AND TRAILING EDGE CROPPING.




TIP CROPPING

41281

Repair details
Fig.807




TO BE APPLIED WHERE SUFFICIENTLY THICK TO OBTAIN RADIUS.

WHERE BLADE IS TOO THICK TO OBTAIN 0,64(025) TO 0,70(.027) RADIUS, THE CONVEX & CONCAVE SIDES OF BLADE ARE TO BE REDUCED OVER DISTANCE SHOWN UNTIL THE RADIUS CAN BE OBTAINED.

IT IS UNACCEPTABLE TO RESTORE LEADING EDGE WITH RADIUS & LEAVE A FLAT AS SHOWN.

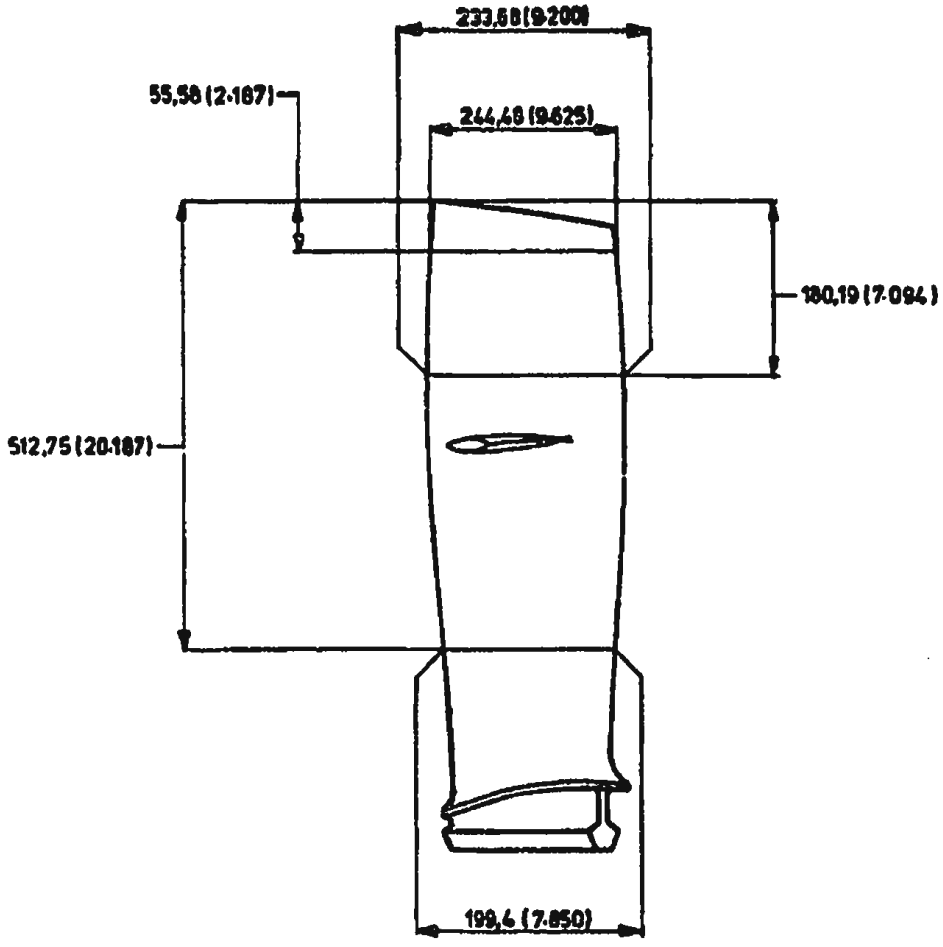
NOTES
POLISH & DRESS TO REMOVE SHARP EDGES & ROUGH SURFACES DUE TO EROSION, THEN RESTORE RADIUS AS SHOWN.

CRACK TEST IN ACCORDANCE WITH INSTRUCTIONS.

WET ABRASIVE BLAST TO TSD 594 OP 104 USING 120/220 GRADE ALUMINIUM OXIDE OVER DRESSED AREA.

RESTORATION OF LEADING EDGE RADIUS. 48938

Repair Details
Fig.807A




MINIMUM CHORDAL WIDTH AFTER DRESSING

44238

Minimum chordal width after dressing
Fig.808

Any combination of scalloping, cropping and dressing may be applied to a given blade provided that the maximum limitation for any one of these is not exceeded by the combination.

Dressing may be accomplished using grinding wheels or mechanised cutters. If grinding wheels are used they must be silicon carbide type and NOT aluminium oxide type.

This Repair has two parts as follows:

A. Repair the damage:

This part covers the application of dressing, cropping and scalloping techniques.

B. Restore leading edge radius:

This part covers the removal of flats from the long side of the blade.

A. Repair the damage

| | Procedure | Supplementary Information |
|---|---|---|
| (1) | Penetrant crack test to determine full extent of damage | |
| (2) | Dress to remove damage | |
| R | | See fig.805 for scalloping. |
| R | | See fig.806 for surface dressing. |
| R | | See fig.807 for tip cropping. Light cuts only may be made if using machanical cutters, to prevent overheating of material. Dressing must be continued until all suspect material is removed. |
| (3) | Blend the dressed areas and polish out dressing scores | |
| R | | See fig.805, 806 and/or 807 for blending limits. Any polish or dressing marks must run in radial direction (i.e. from root to tip of blade). |

| | Procedure | Supplementary Information |
|---|---|---|
| | (4) Visually and dimensionally inspect. Check surface finish | |
| R | | See fig.805, 806 and/or 807. |
| | (5) Penetrant crack test | |
| | (6) Wet abrasive blast the repair area using 120; 200 grade aluminium oxide | Blades repaired on installed engines must be blasted at next shop visit (Ref. T.S.D.594, O.P.104). |
| | (7) Vibro-engrave FRS.3948A on blade root front face | |

B. Restore leading edge radius

| | Procedure | Supplementary Information |
|---|---|---|
| | (1) Restore radius | |
| R | | See fig.805 and 807A, polish or dress to remove sharp corners and rough surface finish. Remove minimum material. See Para.5. Tools |
| | (2) Visually and dimensionally inspect | |
| R | | See fig.805, 807A and 808, check minimum chordal width at 3 places |
| | (3) Crack test | |
| | | T.S.D.594, O.P.213 |

(4) Wet abrasive blast — T.S.D.594, O.P.104. Use 120-220 grade aluminium oxide OMat 146, blast zone 6,35 to 19,05 mm. (0.25 to 0.75 in.) wide each side of leading edge. Blades repaired on installed engines must be blasted at next shop visit

(5) Vibro-engrave FRS.3948B on blade root front face

4. Material of component

| Description | R.R. Symbol | Material |
|---|---|---|
| L.P. compressor blade | TBQ | Titanium alloy |

5. Tools

Leading edge radius tool HU27019

6. Parts

A. Parts required

Not applicable

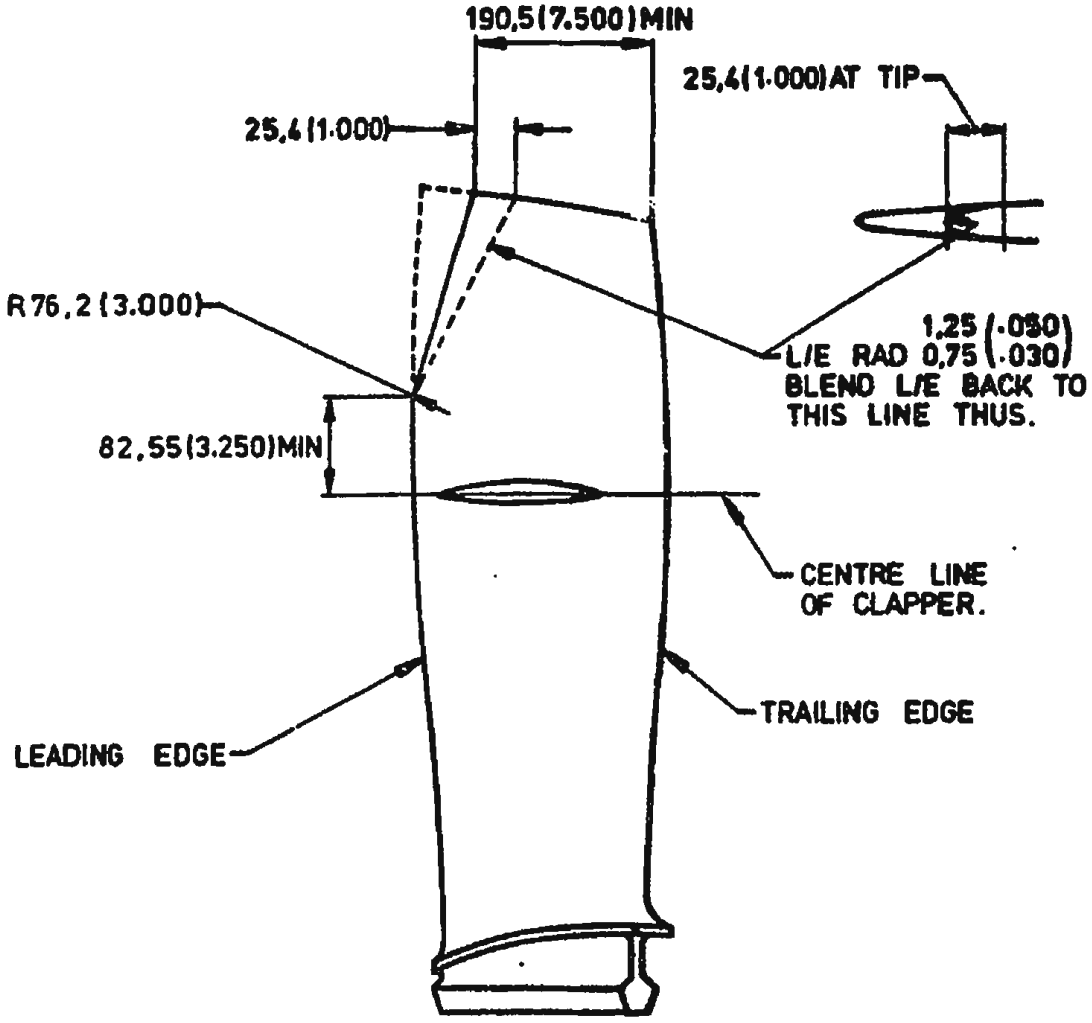
7. Price and availability

Repair of spares - Refer to Rolls-Royce Limited

# L.P. COMPRESSOR BLADES - LEADING EDGE TIP CROPPING - FLY BACK LIMITS ONLY FRS.4378

## 1. Effectivity

| I.P.C. Fig./Item | Part No. | | |
|---|---|---|---|
| 01 280 | LK45971 | | |
| | LK48141 | S.B.72-2213 | Item L |
| | LK50398 | S.B.72-2314 | |
| | LK50397 | S.B.72-2314 | Part 2 |
| | LK54465 | S.B.72-2825 | |
| | LK54466 | S.B.72-2825 | Part 2 |
| | LK57062 | S.B.72-3213 | Part 1 |
| | LK57063 | S.B.72-3213 | Part 2 |
| | LK57064 | S.B.72-3213 | Part 3 |
| | LK57064 | S.B.72-3213 | Part 4 |
| | LK57083 | S.B.72-3213 | Part 5 |
| | LK77455 | S.B.72-5434 | |
| | LK77453 | S.B.72-5434 | |
| | LK81128 | S.B.72-5540 | Part 1 |
| | LK81129 | S.B.72-5540 | Part 1 |
| | LK81130 | S.B.72-5540 | Part 1 |
| | LK78956 | S.B.72-5540 | Part 1 |
| | LK75906 | S.B.72-5540 | Part 1 |
| | LK78958 | S.B.72-5540 | Part 2 |
| | LK79001 | S.B.72-5540 | Part 2 |
| | LK79002 | S.B.72-5540 | Part 2 |
| | LK79003 | S.B.72-5540 | Part 2 |
| | LK79004 | S.B.72-5540 | Part 2 |
| | LK79005 | S.B.72-5540 | Part 2 |
| | LK77517 | S.B.72-5540 | Part 2 |
| | LK81091 | S.B.72-5540 | Part 3 |
| | LK81084 | S.B.72-5540 | Part 3 |
| | LK81085 | S.B.72-5540 | Part 3 |
| | LK81086 | S.B.72-5540 | Part 3 |
| | LK81087 | S.B.72-5540 | Part 3 |
| | LK81088 | S.B.72-5540 | Part 3 |
| | LK81089 | S.B.72-5540 | Part 3 |




L/E TIP CROPPING FLY BACK LIMITS ONLY

45782A

DIMENSIONS ARE IN MILLIMETRES WITH INCH CONVERSIONS IN PARENTHESES.

Cropping dimensions
Fig.809

## 2. General

A. The tip cropping outlined in this Repair is allowable only for fly back purposes (a maximum of 125 hours or 25 flights whichever is sooner).

B. This Repair is intended as an 'in-situ' operation on an assembled engine.

C. Up to three fan blades in a fan set can be cropped back to the maximum allowable limits. If the three cropped blades are adjacent, it will be necessary to remove a similar amount from blades opposite those cropped to minimise out of balance of the engine.

D. Dressing and scalloping as described in FRS.3948 can also be implemented in conjunction with this Repair.

E. When any blade is cropped as described in paragraph C., a vibration survey is required. Ref.71-00-00 P.B.501, Adjustment/Test, Test No.11.

## 3. Instructions

A. Dress the damage

| | Procedure | Supplementary Information |
|---|---|---|
| (1) | Penetrant crack test to determine full extent of damage | |
| (2) | Mark out to determine extent of cropping required | |
| R | | See fig.809 |
| (3) | Remove damaged part of blade tip and equivalent area of opposite blade | |
| R | | See fig.809. Light cuts only can be made, if using mechanical cutters, to prevent overheating of material |

| | Procedure | Supplementary Information |
|---|---|---|
| R | (4) Blend cropped area | See fig.809, for blending limits. Any polish or dressing marks must run in radial direction (i.e. from root to tip of blade |
| R | (5) Visually and dimensionally inspect | See fig.809. Ensure smooth surface finish |
| | (6) Penetrant crack test | |
| | (7) Effect engine vibration survey | Ref.71-00-00 P.B.501, Adjustment/ Test, Test No.11 |
| | (8) Endorse engine log book with FRS.4378 | |

4. Material of component

| Description | R.R. Symbol | Material |
|---|---|---|
| L.P. compressor blade | TBQ | Titanium alloy |

5. Tools

Special tools are not required.

6. Parts

A. Parts required

Not applicable.

7. Price and availability

Not applicable.

## INTERMEDIATE PRESSURE (I.P.) COMPRESSOR - INSPECTION/CHECK

1. Inspect I.P. Compressor Blades

A. Inspection

(1) Using borescope equipment and procedure (Ref. 72-00-00, Inspection/Check, para.3) inspect as far as possible airfoil surfaces of I.P. compressor blades for the following damage:

(a) Cracks and tears.

(b) Nicks.

(c) Dents.

(d) Tip failures, bending and rubs.

For acceptance standards see para.B.

B. Acceptance standards

(1) To assist in assessing damage, the dimensions of I.P. compressor blades are given on fig.601.

R (a) Accept nicks and tears emanating from leading and
R trailing edges, providing no cracking from damage
R is evident, up to 0.015in. (0,381 mm.).

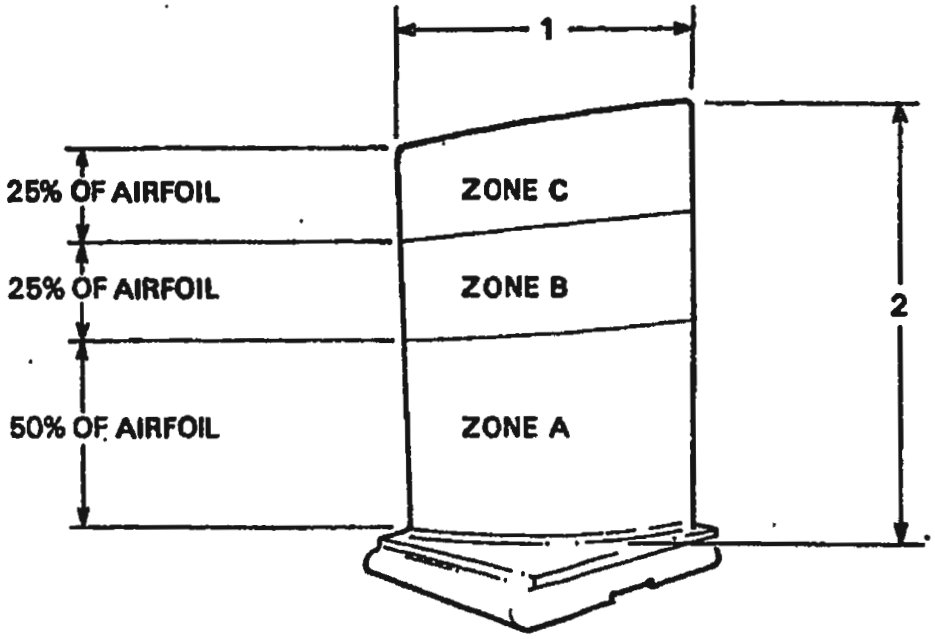
C NOTE: Contents of NOTE deleted at request of operator
C (LASC CIC 2312 TW 29.1.91).

(2) Zone A

(a) Cracks, nicks and/or tears in one edge, providing the individual true lengths do not exceed 5% of blade chord width.

(b) Cracks, nicks and/or tears in both edges, providing the individual true lengths on each edge do not exceed 2.5% of blade chord width.

(c) Dents not associated with nicks, cracks or tears.




| STAGE | APPROXIMATE BLADE HEIGHT (Measured in a straight line at vertical centre-line)-Ref. 2 | | APPROXIMATE BLADE WIDTH (Measured in a straight line at airfoil mid-height position)-Ref.1 | | | |
|---|---|---|---|---|---|---|
| | | | TRUE WIDTH * | | PROJECTED WIDTH * | |
| | ins. | mm. | ins. | mm. | ins. | mm. |
| 1 | 6.3 | 160,02 | 3.3 | 83,82 | 2.7 | 68,58 |
| 2 | 5.4 | 137,16 | 3.0 | 76,2 | 1.9 | 48,26 |
| 3 | 4.7 | 119,38 | 2.5 | 63,5 | 1.5 | 38,1 |
| 4 | 4.3 | 109,22 | 2.2 | 55,88 | 1.4 | 35,56 |
| 5 | 3.9 | 99,06 | 2.2 | 55,88 | 1.3 | 33,02 |
| 6 | 3.7 | 93,98 | 2.2 | 55,88 | 1.2 | 30,48 |
| 7 | 3.5 | 88,9 | 2.3 | 58,42 | 1.1 | 27,94 |

* The TRUE BLADE WIDTHS are measured chordally at mid-airfoil height.
* The PROJECTED BLADE WIDTHS are the apparent blade widths as viewed from the boroscope position and represent the circumferential projection of the blade airfoil.

26746C

I.P. compressor blade acceptance zones
Fig.601

C (d) If conditions exceed (2), (a) or (b), schedule
C engine change within 25 flight hours.

(3) Zone B

(a) Cracks, nicks and/or tears in one edge, providing the individual true lengths do not exceed 5% of blade chord width.

(b) Cracks, nicks and/or tears in both edges, providing the individual true lengths on each edge do not exceed 2.5% of blade chord width.

R (c) Fly on limits for Zone B cracks, nicks and/or tears.

R (i) The limit for Zone B can be extended by up to
R 50% of the individual limits in (a) or (b)
R above for a maximum of 25 hours or 5 flights
R whichever is the sooner. This is to enable an
R operator to accomplish an engine change at
R base.

CR (ii) If condition exceeds (3) (c) (i) contact MCIEE
CR before flight.

(d) Dents not associated with nicks, cracks or tears.

(4) Zone C

(a) A single crack from the blade tip, not associated with damage and providing the true length does not exceed 10% of blade chord width.

(b) Cracks, nicks and/or tears in one edge, providing the individual true lengths do not exceed 15% of blade chord width.

(c) Cracks, nicks and/or tears in both edges, providing the individual true lengths on each edge do not exceed 7.5% of blade chord width.

R (d) Fly on limits for Zone C cracks, nicks and/or tears.

R (i) The limit for Zone C can be extended by up to
R 100% of the individual limits in (a), (b), (c)
R above for a maximum of 25 hours or 5 flights
R whichever is the sooner. This is to enable an
R operator to accomplish an engine change at
R base.

CR (ii) If condition exceeds (4) (d) (i) contact MCIEE
CR before flight.

(e) Dents, not associated with cracks, nicks or tears.

(f) Blades with either a detached leading edge tip and/or a detached trailing edge tip up to a total of approximately 30% chord width, provided that the subsequent stages of blades are examined.

(g) Bending or curling at a blade tip, with associated cracking or tearing not exceeding 20% chord width in true length.

(h) Heat discolouration associated with tip rubs.

CR (j) If conditions exceed (4), (f) or (g), schedule
CR engine change within 25 flights hours.

C C. Acceptance Standard - Disc and Blade Root Alignment
C Stages 2 through 7

C NOTE: To assist in assessing blade movement nominal
C thickness of lock plates stages 2/4/5 is 0.050in.
C (1.27 mm.).

C (1) Up to 0.025in. (0.64 mm.) out of alignment between
C rear edge of blade platform and rear edge of disc
C dovetail acceptable.

C (2) 0.025in. to 0.100in. (0.64 mm. to 2.54 mm.) out of
C alignment between rear edge of blade platform and
C rear edge of disc dovetail acceptable for 50 flt.
C hours.

C (3) Over 0.100in. (2.54 mm.) engine removal.

C NOTE: Any time 0.025in. (0.64 mm.) or above found
C out of alignment, notify MCI Engineering.

D. Borescope Blanking Plug, engines with S.B.72-5854.

(1) Wear on shoulder - Reject.

(2) Plug head loose on stem due to failure of braze material - Reject.

E. Blade material missing from leading/trailing edge.

(1) Without associated cracking provided within the limits of (2)(a)(b), (3)(a)(b) and (4)(a)(b)(c) - Accept.

## COMPRESSOR INTERMEDIATE CASE - INSPECTION/CHECK

R Referenced Procedures:

R 72-00-00 Engine - Inspection/Check
R 72-03-00 Gas Generator Fairings - Removal/Installation
R 78-30-00 Thrust Reverser - Servicing

R Illustrated Parts Catalogue References:

R The I.P.C. sections where parts disturbed during the following
R operations can be located, are as follows:

R 72-33-10 Intermediate Compressor Casing

1. Inspect intermediate case outer annulus strut webs

A. Inspection

WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION (REF.78-30-00) WHILE WORK IS IN PROGRESS

(1) Equipment required;

CP.20309 or XUT.37594 Working platform
or (XUT.42526 Spacer
(XUT.42527 Side piece
Clean, stiff-bristled brush

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | B.S.4487: 1969 | Mil-T-81533 | 1/21 |
| Jointing compound | DTD.900/ 4586 (Hylomar light) | - | 426A |

(3) Deactivate and tag thrust reverser and associated systems and fit mechanical locks (Ref. 78-30-00).

(4) Position working platform in cold stream duct

(5) Remove compressor section L.H. and R.H. rear fairing (Ref. 72-03-00).

(6) Remove H.P.1 rotor sealing tube, H.P. 1R (Ref. 72-00-00).

(7) Remove I.P.7 air offtake blanking plates, circumferentially positioned at approximately 4 o'clock and 9 o'clock (viewed from rear) on compressor intermediate case.

(8) Using boroscope equipment (Ref. 72-00-00) through the apertures, exposed by operations (6) and (7), inspect, as far as possible, the trailing edges of the outer annulus strut webs for cracking and damage.

For acceptance standards see 1.B.

(9) After inspection, remove boroscope equipment.

(10) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Moisten a cloth with degreasing fluid and remove all traces of old jointing compound from I.P.7 offtake mating face, and mating face of blank plate.

(11) CAUTION: ENSURE BOROSCOPE PLUG AND I.P. AIR OFFTAKE BLANKING PLATES ARE FITTED AND SECURED AFTER BOROSCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
Brush apply thin film of jointing compound to I.P.7 offtake mating face, also to mating face of blank plate: allow compound to dry for a minimum of 10 minutes.

(12) Fit and secure H.P.1R sealing tube (Ref. 72-00-00) and the two I.P. air offtake blanking plates.

(13) Fit and secure compressor section L.H. and R.H. rear fairing (Ref. 72-03-00).

(14) Remove working platform from cold stream duct.

(15) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00).

B. Acceptance standards

(1) Cracking

(a) A single crack per strut is acceptable.

(b) Cracking which is liable to cause a piece of strut to become detached is not acceptable.

(c) Cracking which extends completely through the chordal length of the strut is not acceptable.

(d) Cracking which extends from the strut into the outer wall of the annulus is not acceptable.

(2) Damage

(a) Struts with missing pieces are not acceptable.

2. Inspect Intermediate Case Inner Annulus Panels

A. Inspection

WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION (REF. 78-30-00). WHILE WORK IS IN PROGRESS.

(1) Equipment required:

289200 or C 4G 4342 Protective work mats
Clean, stiff-bristled brush

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | B.S.4487: 1969 | Mil-T-81533 | 1/21 |
| Jointing compound | DTD.900/ 4586 (Hylomar light) | - | 426A |

(3) Deactivate and tag thrust reverser and associated systems and fit thrust reverser mechanical locks (Ref. 78-30-00).

(4) Position work mats in cold stream duct.

(5) Remove access panel in compressor section R.H. rear fairing.

(6) Remove H.P.1 rotor sealing tube, H.P.1R (Ref. 72-00-00).

(7) Using boroscope equipment (Ref. 72-00-00) carefully insert probe with viewing aperture facing forward in H.P.1R access port and inspect intermediate case inner platform for cracking then withdraw probe; for acceptance standards, see 2.B.

(8) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Using degreasing fluid, clean mating faces of case and H.P.1R sealing tube; allow to dry.

(9) Brush apply thin film of jointing compound to mating faces of case and H.P.1R sealing tube; allow compound to dry for 10 minutes.

(10) CAUTION: ENSURE H.P.1R SEALING TUBE IS CORRECTLY FITTED AND SECURED AFTER BOROSCOPE INSPECTION. FAILURE TO DO SO CAN RESULT IN ENGINE DAMAGE.
Fit and secure H.P.1R sealing tube (Ref. 72-00-00).

(11) Fit and secure access panel in compressor section R.H. rear fairing.

(12) Remove work mats from cold stream duct.

(13) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00).

B. Acceptance Standards

(1) Cracks

(a) A single axial crack is acceptable.

(b) All other cracks are unacceptable.

C 3. Inspect flanges and mounting brackets adjacent to step-aside
C gearbox (Steel case only)

C A. Remove radial drive fairing.

C B. Inspect raft web and mounting brackets for cracks.

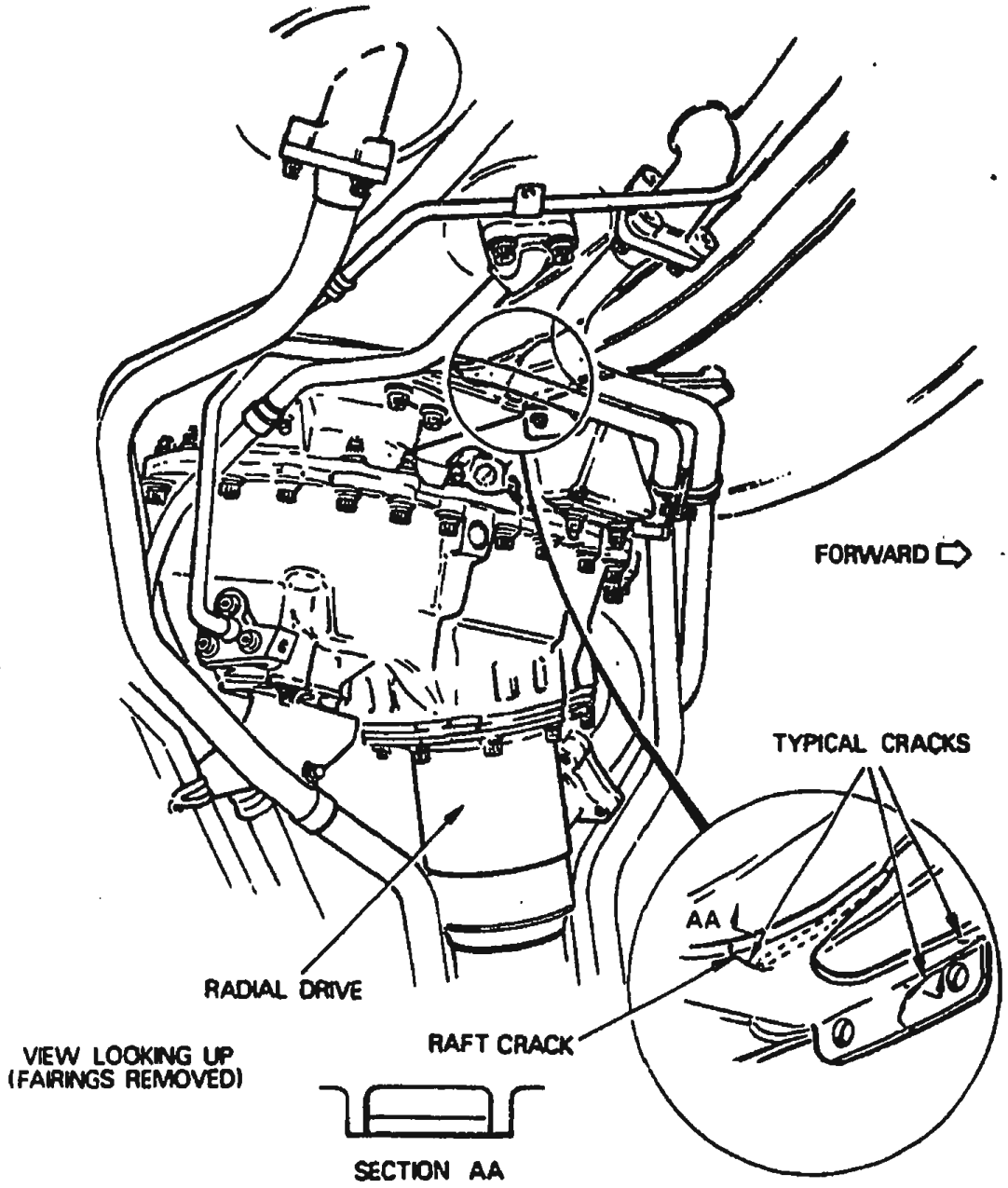
C C. Acceptance Limits.

C (1) Raft cracks; acceptable for the current service life.

C (2) Mounting lug failure; failure of one lug such that one
C bolt in it is still effective is acceptable.

C (3) Both lugs cracked or both bolts in one lug failed will
C require corrention within 25 flight hours.

C D. Reinstall radial drive fairing.




CR Step aside gearbox mounting raft webs - Typical cracks
CR Fig.601

R 4. Inspect Compressor Intermediate Case Strut Bolts

R A. Inspection

R (1) Equipment required:

R XUT42526 Spacer
R XUT42527 Side pieces
R UT951/1 Screwdriver

R (2) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION (REF. 78-30-00) WHILE WORK IS IN PROGRESS.
R Deactivate and tag thrust reverser and associated systems and fit thrust reverser locks (Ref. 78-30-00).

R (3) Position spacer and side pieces in cold stream duct.

R (4) Remove compressor section fairings (Ref. 72-03-00).

R (5) Refer to fig.602, inspect bolt positions at compressor intermediate case to front and rear inner spoke for missing heads.

R For acceptance standards see para.4.B.

R (6) Fit compressor section fairings (Ref. 72-03-00).

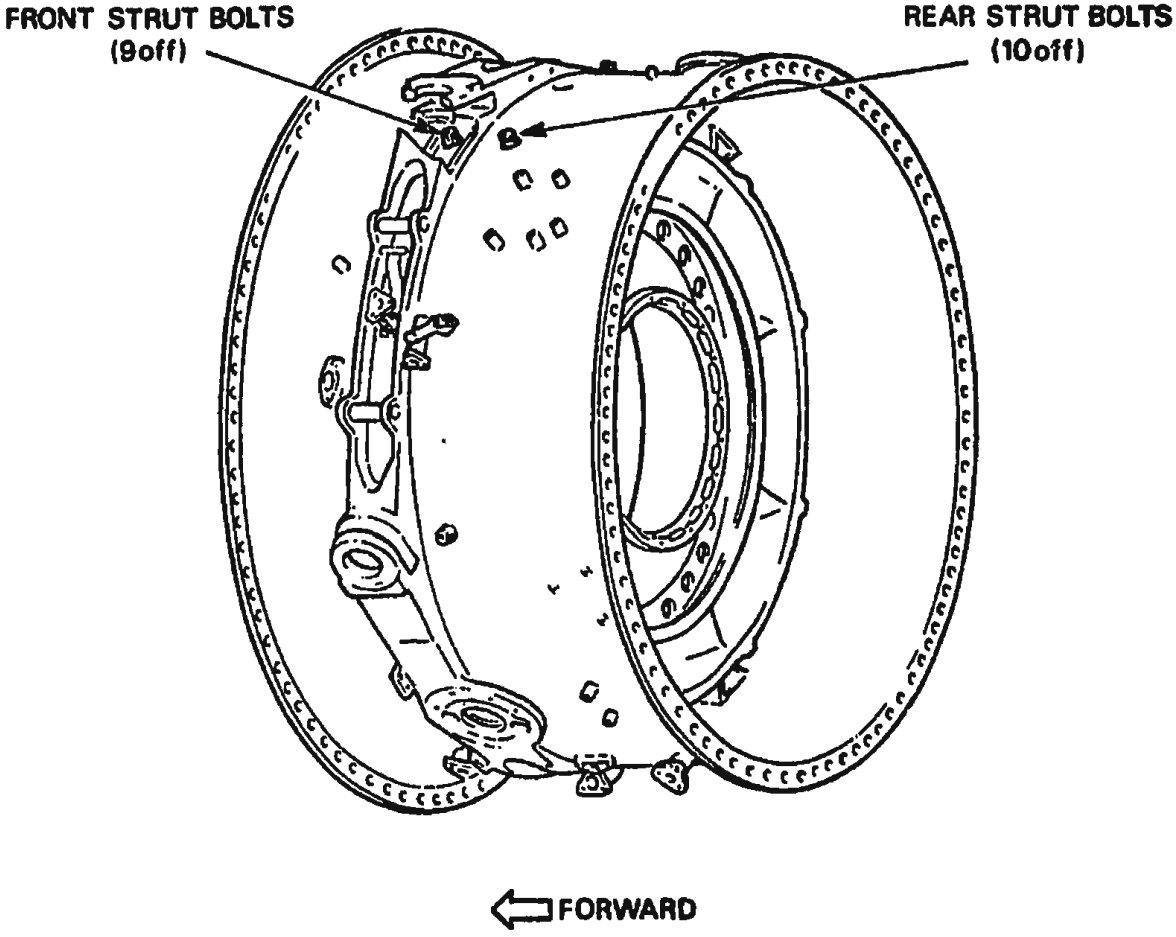
R (7) Remove spacer and side pieces from cold stream duct.

R (8) Remove tags and re-activate thrust reverser and associated systems (Ref. 78-30-00).

R B. Acceptance Standards

R (1) Not more than 2 bolt heads missing - Re-inspect every 300 hours.

R (2) More than 2 bolt heads missing - Schedule engine removal within 25 hours.




93050

R Bolt locations - Compressor intermediate case
R Fig.602

R COMPRESSOR INTERMEDIATE CASE - STEEL -

R REWELD BROKEN MOUNTING LUG

R L.H. OR R.H.

R FRS.4258

R This repair covers:

R Rewelding the broken portion of the L.H. or R.H. lug when the
R broken portion is available because it is still attached to
R the bolt on the step aside gearbox.

R This Repair is intended to be effected on a built-up engine.

R 1. Effectivity

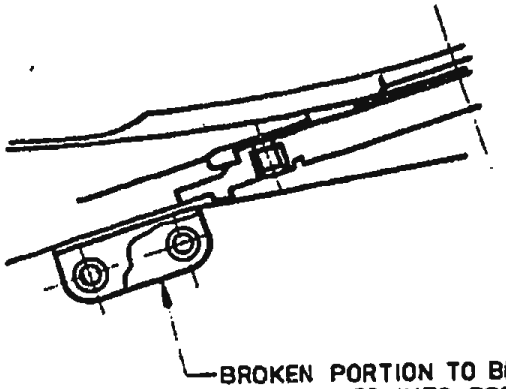
| R | I.P.C. Fig./Item | Part No. |
|---|---|---|
| R | 02A 500 | LK63749 |
| R | | LK67139 |
| R | | LK65862 |
| R | | LK68621 |
| R | | LK67238 |

R 2. Instructions

R CAUTION: BEFORE WELDING ENSURE ADEQUATE FIRE PRECAUTIONS HAVE
R BEEN TAKEN.

R A. Replace broken mounting lug

| R | | Procedure | Supplementary Information |
|---|---|---|---|
| R | (1) | Clamp the broken portion in position. Ensure a good notch is made for full weld penetration. | See fig.801. Tungsten carbide cutter. |
| R | (2) | Clean and prepare the surface locally. | Cold liquid degrease, OMat 1/21 |


BROKEN PORTION TO BE ARGON ARC WELDED INTO POSITION. EDGES MUST BE IN LINE PRIOR TO WELDING. ANY WELD BEAD TO BE DRESSED FLUSH WITH PARENT METAL

SECTION AT MOUNTING LUG

37915

| | Procedure | Supplementary Information |
|---|---|---|
| (3) | Argon arc weld the broken portion to the remainder of the lug. Ensure edges are in line. | See fig.801 and 4. Welding data. |
| (4) | Dress any weld bead flush with parent metal on top and bottom surfaces. | |
| (5) | Crack test the welded area. | |
| (6) | Paint the exposed areas and allow to air dry. | Use high heat resisting paint (Ref. 70-42-12). |
| (7) | Vibro-engrave FRS.4258 adjacent to part number. | |

3. Material of component

| Description | R.R.Symbol | Material |
|---|---|---|
| Compressor intermediate case | EAK | 12 per cent chrome steel |

4. Welding data

| | |
|---|---|
| Type of welding .. .. .. .. | Argonarc D.C. output |
| Torch .. .. .. .. .. .. | B.O.C.200 |
| Electrode .. .. .. .. .. | Thoriated tungsten |
| Current .. .. .. .. .. | 45-55 amp. |
| Filler rod .. .. .. .. .. | Jethete M.190 |
| | R.R. Reference Ms.950/10 20 S/W.G. OMat 3/54 |
| Argon flow .. .. .. .. .. | 20 cubic/feet/hour |

This data is given for guidance only, for further information refer to T.S.O.594, O.P.409.

R 5. Parts

R A. Parts required

R Not applicable.

R L.P. COMPRESSOR CASE SUPPORT STRUCTURE - REMOVAL/INSTALLATION

R 1. Removal/Installation L.P. Compressor Case Support Assembly
R Fairings

R WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD
R THRUST POSITION (REF. 78-30-00, SERVICING) WHILE WORK
R IS IN PROGRESS.

R A. Remove L.P. Compressor Case Support Assembly Fairings

R (1) Equipment required:

R CP.20309 or XUT.37594 Working platform

R (2) Tag throttle levers and thrust reverser levers. Tag
R APU/GRD AIR TO REVERSERS switches.

R (3) On pilots overhead circuit breaker panel CB1, zone 210,
R open and tag appropriate THRUST REVERSE circuit
R breaker.

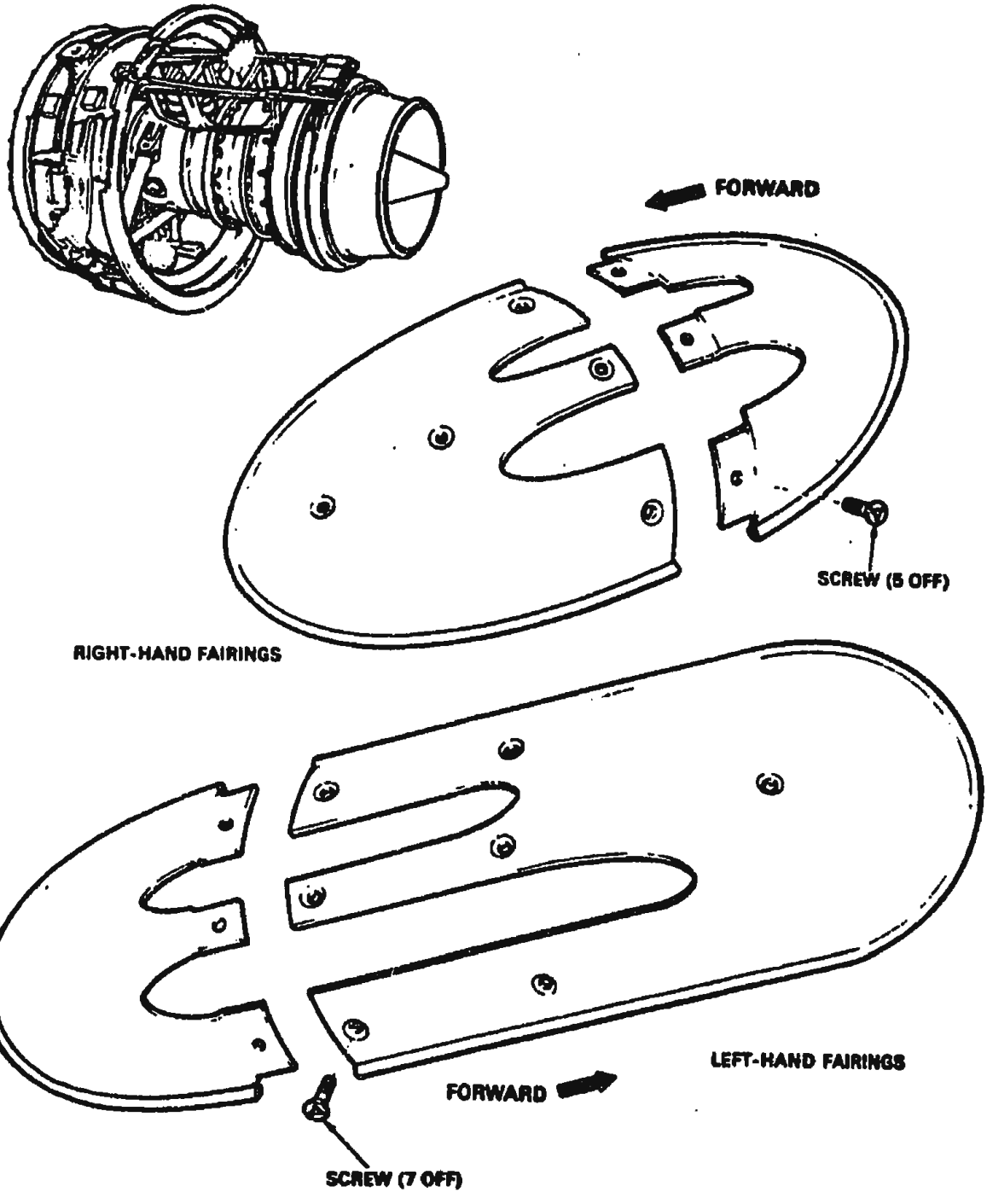
R (4) On Flight Engineer/Second Officers aft circuit breaker
R panel CB3, zone 215, open and tag appropriate START
R AIR VALVE circuit breaker.

R (5) Tag appropriate ENGINE START panel switchlights.

R (6) Position working platform in cold stream duct.

R (7) Refer to fig.401 or fig.402 as appropriate, enter cold
R stream duct and remove left-hand and right-hand
R fairings.

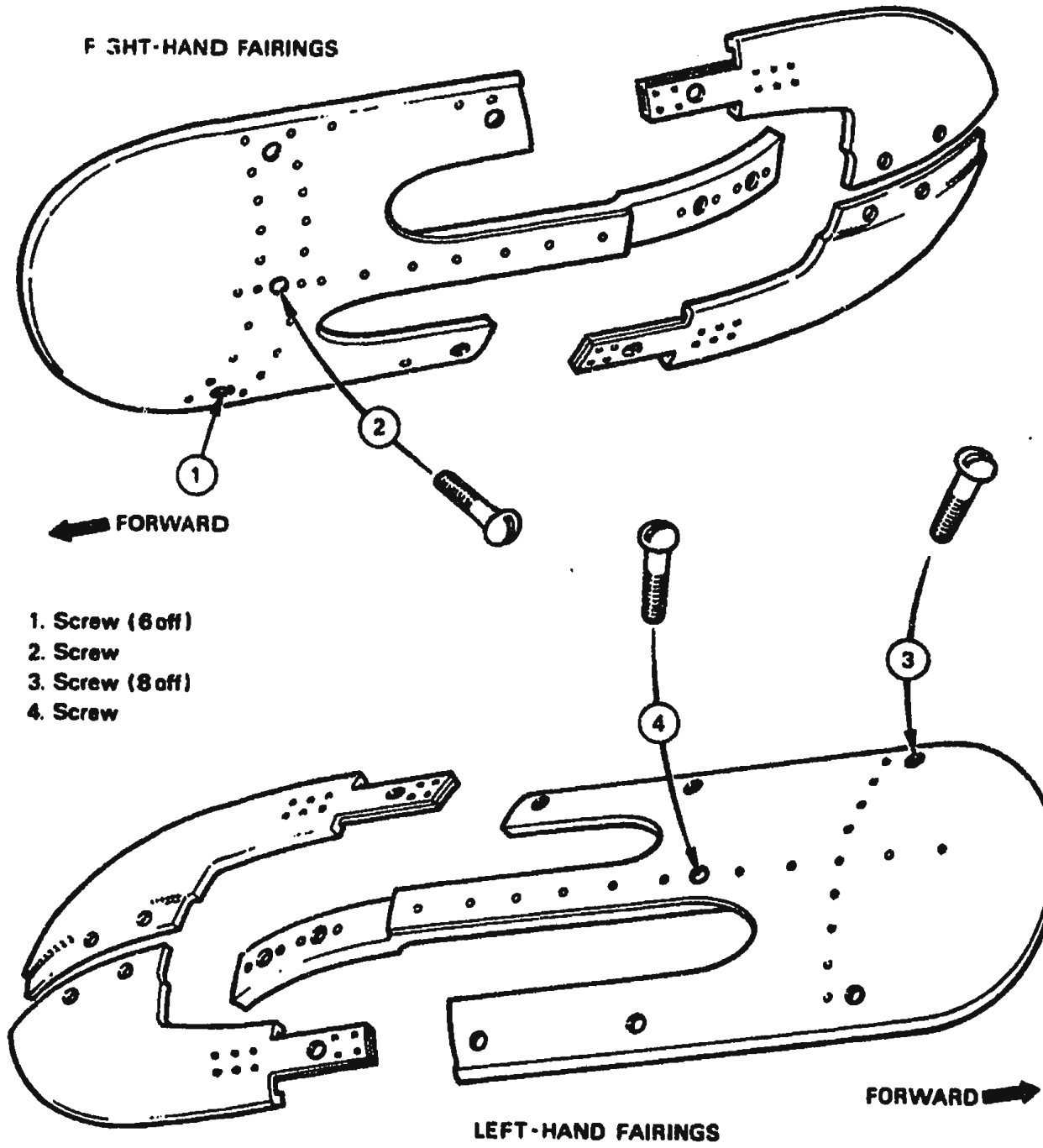
R (8) Remove working platform from cold stream duct.




26148

R L.P. compressor case support assembly fairings removal/installation
R Fig.401

R EFFECTIVITY: ALL




R L.P. compressor case support assembly fairings
R (S.B.72-2019) removal/installation
R Fig.402

R EFFECTIVITY: ALL

R B. Install L.P. Compressor Case Support Assembly Fairings

R (1) Ensure appropriate systems are tagged as detailed in
R operation A.(2) through (5).

R (2) Ensure working platform fitted in cold stream duct.

R (3) Refer to fig.401 or fig.402 as appropriate, enter cold
R stream duct and fit left-hand and right-hand fairings.

R (4) Remove working platform from cold stream duct.

R (5) Remove tags and close circuit breakers opened in
R operation A.(2) through (5).

## L.P. COMPRESSOR CASE SUPPORT STRUCTURE - INSPECTION/CHECK

### 1. Inspection/Check

WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION (REF. 78-30-00, SERVICING) WHILE WORK IS IN PROGRESS.

A. Inspect L.P. Compressor Case Support Structure and Fairings

(1) Equipment required:

CP.20309 or XUT.37594 Working platform

(2) Tag throttle levers and thrust reverser levers. Tag APU/GRD AIR TO REVERSERS switches.

(3) On pilots overhead circuit breaker panel CB1, zone 210, open and tag appropriate THRUST REVERSE circuit breaker.

(4) On Flight Engineer/Second Officers aft circuit breaker panel CB3, zone 215, open and tag appropriate START AIR VALVE circuit breaker.

(5) Tag appropriate ENGINE START panel switchlights.

(6) Open left-hand hinged cowl 413A and 423A for engines No.1 and 3 (Ref. 71-11-00, Servicing) or 433AL and 433DL for engine No.2 (Ref. 71-12-01 and 05, Servicing). Open right-hand hinged cowl 414A or 424A for engines No.1 and 3 (Ref. 71-11-00, Servicing) or 434AR and 434DR for engine No.2 (Ref. 71-12-01 and 05, Servicing).

(7) Inspect L.P. compressor support structure locating connectors on L.P. compressor case for security of attachment and cracks.

(8) Inspect L.P. compressor case adjacent to locating connectors for cracks.

(9) Position working platform in cold stream duct.

(10) Enter cold stream duct and remove combustion section L.H. and R.H. side fairings and compressor section L.H. and R.H. rear fairings (Ref. 72-03-00).

(11) Remove left-hand and right-hand support assembly fairings (Ref. 72-33-02, Removal/Installation).

(12) Inspect left-hand and right-hand L.P. compressor case support assembly mounting pins for security in I.P. compressor case lugs.

(13) Inspect I.P. compressor case lugs and adjacent area of case for cracks.

(14) Inspect left-hand and right-hand support struts, where visible, for cracks.

(15) Inspect left-hand and right-hand support strut
R fairings for cracks, damage and erosion.

(16) Inspect left-hand and right-hand support assembly fairings for cracks.

(17) Fit left-hand and right-hand support assembly fairings (Ref. para.2).

(18) Fit compressor section L.H. and R.H. rear fairings and combustion section L.H. and R.H. side fairings (Ref. 72-03-00).

(19) Remove working platform from cold stream duct.

(20) Close left-hand hinged cowl 413A or 423A for engines No.1 and No.3 (Ref. 71-11-00, Servicing) or 433AL and 433DL for engine No.2 (Ref. 71-12-01 and 05, Servicing). Close right-hand hinged cowl 414A or 424A for engines No.1 and 3 (Ref. 71-11-00, Servicing) or 434AR and 434DR for engine No.2 (Ref. 71-12-01 and 05, Servicing).

(21) Remove tags and close circuit breakers opened in operations (2) through (5).

B. Acceptance Standards

Cracks found in operations A.(7), (8), (13) and (14) are not acceptable.

Damage within following limitations is acceptable:

(1) L.P. compressor case support strut fairings.

R (a) Loss of anti-erosion coating - Accept.

R (b) Erosion/damage to glass reinforced plastic (G.R.P.).

R Loss of part or whole of the G.R.P. fairing is
R acceptable provided loose material is removed
R to prevent interference with the PF rake and
R repair is carried out at next engine removal,
R or earlier in accordance with FRS5947
R (Ref.72-33-02, Approved Repairs) if convenient.

(2) L.P. compressor case support assembly fairings.

One crack up to 0.50in. (12,70 mm.) in length on each fairing, provided it does not run into a screw hole.

If damage is not acceptable, remove fairing and fit new fairing.

R L.P. COMPRESSOR CASE SUPPORT STRUCTURE -
R APPROVED REPAIRS
R LIST OF REPAIRS


| R Repair No. | Title | Page No. |
|---|---|---|
| R FRS5947 | L.P. Compressor Case - Support Structure - ('A' Frame) - Temporary Repair | 803 |

R This page left blank intentionally

# L.P. COMPRESSOR CASE - SUPPORT STRUCTURE ('A' FRAME) - TEMPORARY REPAIR FRS5947

## 1. Effectivity

| I.P.C. Fig./Item | Part No. |
|---|---|
| 01 085 | All |
| 01 185 | All |

## 2. Equipment and Material

A. Standard equipment

Workshop tools
Heat lamps or hot air gun

B. Consumable materials

OMat 5/97 Garnet paper
OMat 5/98 Garnet paper
OMat 1/21 Trichloroethane
OMat 803 Resin
OMat 802 Hardener
OMat 8/8 Resin
OMat 8/9 Hardener
OMat 887 Fibreglass cloth

NOTE: 1. The OMat 802, 803 system and OMat 8/8, 8/9 system are alternatives.

2. To identify consumable materials refer to Overhaul Materials Manual, OMat.

C. Special tools - none required.

D. Expendable parts - none required.

E. Repair parts - none required.

R 3. General

A. This Repair scheme details the methods and materials for temporarily securing loose material on L.P. compressor support strut fairings, until a permanent repair can be carried out using an appropriate repair scheme.

B. General precautions

(1) Maximum attention must be paid to cleanliness throughout this repair as any dirt or grease on bonding surfaces will result in poor adhesion and unsatisfactory bonds.

(2) Clean white cotton or polythene gloves must be worn, where possible, by all personnel handling parts to be bonded, handling must be kept to a minimum, and components must not be handled on prepared surfaces.

C. Material of components

| DESCRIPTION | RR SYMBOL | MATERIAL |
|---|---|---|
| L.P. compressor support strut | EAK or TCA | Corrosion resistant steel<br>Titanium |
| Fairing | VCW or VCM | Rigid lightweight foam<br>Nomex honeycomb |

R 4. Prepare Fairing for Application of Wet Lay-Up

| PROCEDURE | SUPPLEMENTARY INFORMATION |
|---|---|
| A. Remove all loose or contaminated material and trim glass cloth | Use workshop tools |
| B. Abrade surface of glass cloth over an area 1.00in. (25,4 mm.) larger than repair area | Use OMat 5/97 or 5/98 garnet paper |
| C. Swab degrease repair area | T.S.D.594, O.P.101.<br>Use OMat 1/21 trichloroethane and a clean dry lint free cloth |

R 5. Apply Wet Lay-Up to Repair Area

| R | PROCEDURE | SUPPLEMENTARY INFORMATION |
|---|---|---|
| R | A. Prepare the resin | |
| R | | Mix 100 parts by weight (p.b.w.) OMat 803 resin with 10 p.b.w. OMat 802 hardener. Alternatively mix 100 p.b.w. OMat 8/8 resin with 20 p.b.w. OMat 8/9 hardener. Mix either system to obtain a homogenous mixture |
| R | B. Brush coat the whole of the repair area with resin | |
| R | C. Apply 2 layers of glass cloth and resin lay-up to repair area. Final lay-up to overlap repair area by 1.00in. (25,4 mm.) | |
| R | | Use OMat 887 fibreglass cloth. Thoroughly wet fabric to a uniform appearance. Ensure air is not trapped between layers |
| R | D. Cure the wet lay-up | |
| R | | Cure at room temperature (minimum 18 deg.C. (64 deg.F.)) for 24 hours. Alternatively cure at room temperature for 2 hours followed by 60 deg.C. (140 deg.F.) for 3 hours using heat lamps or hot air gun |
| R | E. Trim off any loose fibres | |
| R | | Use workshop tools |

R 6. Inspect

| R | PROCEDURE | SUPPLEMENTARY INFORMATION |
|---|---|---|
| R | A. Visually inspect to ensure good adhesion | |

R 7. Identify

| R | PROCEDURE | SUPPLEMENTARY INFORMATION |
|---|---|---|
| R | A. Vibro-engrave FRS5947 adjacent to part number | |

## HIGH PRESSURE (H.P.) COMPRESSOR - INSPECTION/CHECK

1. Inspect H.P. Compressor Rotor Blades

A. Inspection

CR (1) DELETED.

(2) Using borescope equipment and procedure (Ref. 72-00-00, Inspection/Check, para.4) inspect as far as possible airfoil surfaces of H.P. compressor rotor blades for the following damage:

(a) Cracks and tears.

(b) Nicks.

(c) Dents.

(d) Tip failures, bending and rubs.

(e) Evidence of sharp-edged, hard object damage to the airfoil trailing edge of stage 5 or the airfoil leading edge of stage 6 which indicates abutment pad release.

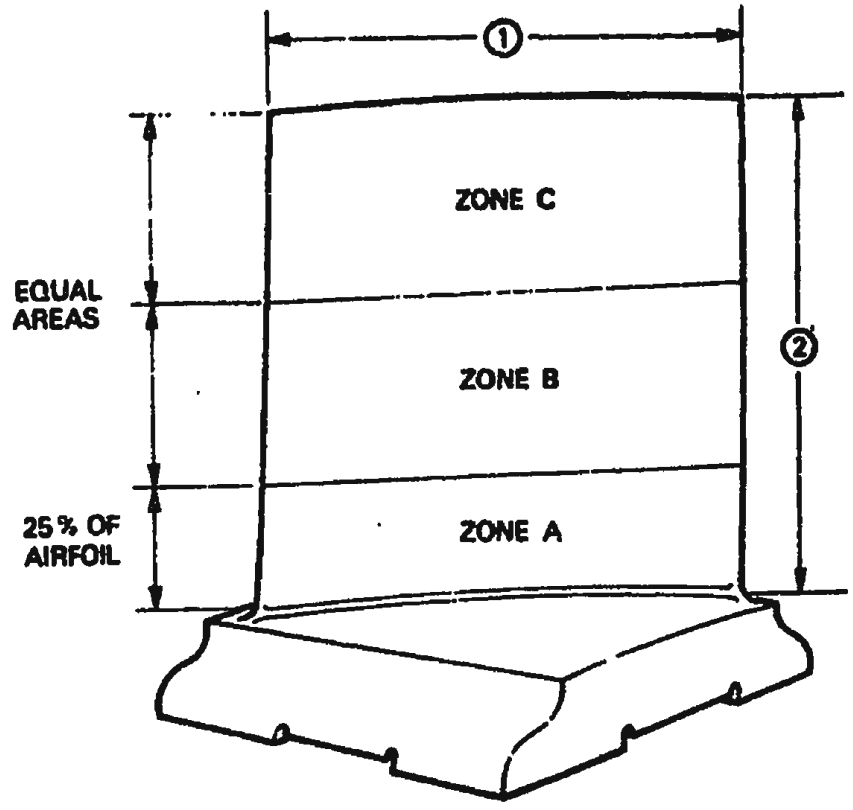
For acceptance standards see para.B.

(3) Using borescope equipment and procedure (Ref.72-00-00, Inspection/Check, para.4) inspect the stage 5 blade platform rear edges, the stage 6 blade platform front edges and the lockplates for the following:

(a) Excessive rearward projection of blades/lockplates

(b) Rubs

For acceptance standards see para.C.




(1) The approximate widths of the blades (measured in a straight line at mid-height position) are as follows:—

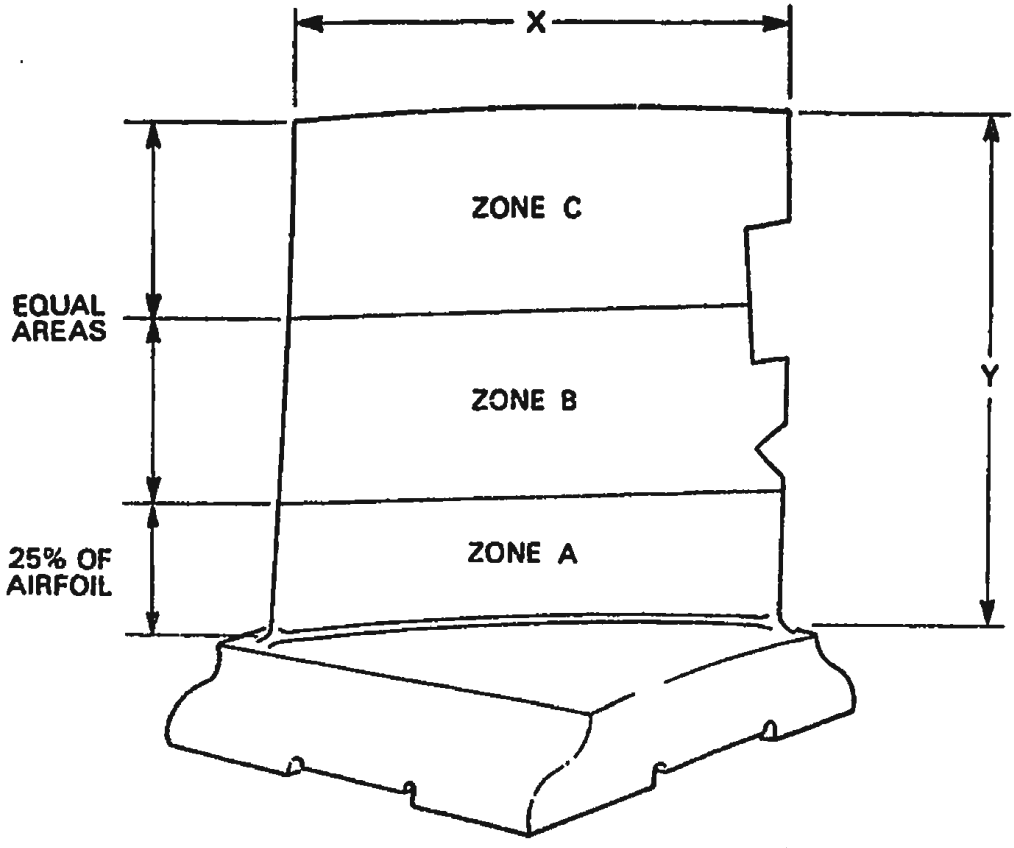
| | | |
|---|---|---|
| STAGE 1 | 1.7 | in. |
| STAGE 2 | 1.4 | in. |
| STAGE 3 | 1.2 | in. |
| STAGE 4 | 1.4 | in. |
| STAGE 5 | 1.3 | in. |
| STAGE 6 | 1.25 | in. |

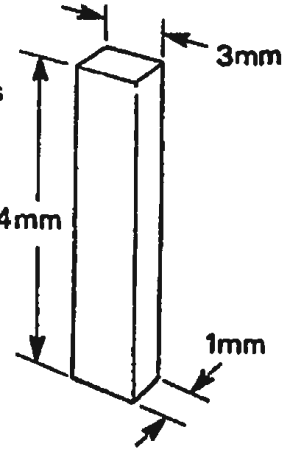
(2) The approximate heights of the blades (measured in a straight line at vertical centre-line) are as follows:—

| | | |
|---|---|---|
| STAGE 1 | 2.5 | in. |
| STAGE 2 | 2.2 | in. |
| STAGE 3 | 1.6 | in. |
| STAGE 4 | 1.4 | in. |
| STAGE 5 | 1.2 | in. |
| STAGE 6 | 1.1 | in. |

26545C

H.P. compressor blade acceptance zones
Fig.601 (Sheet 1)




Approximate dimensions of abutment pad

X The approximate widths of the blades (measured in a straight line at mid-height position) are as given

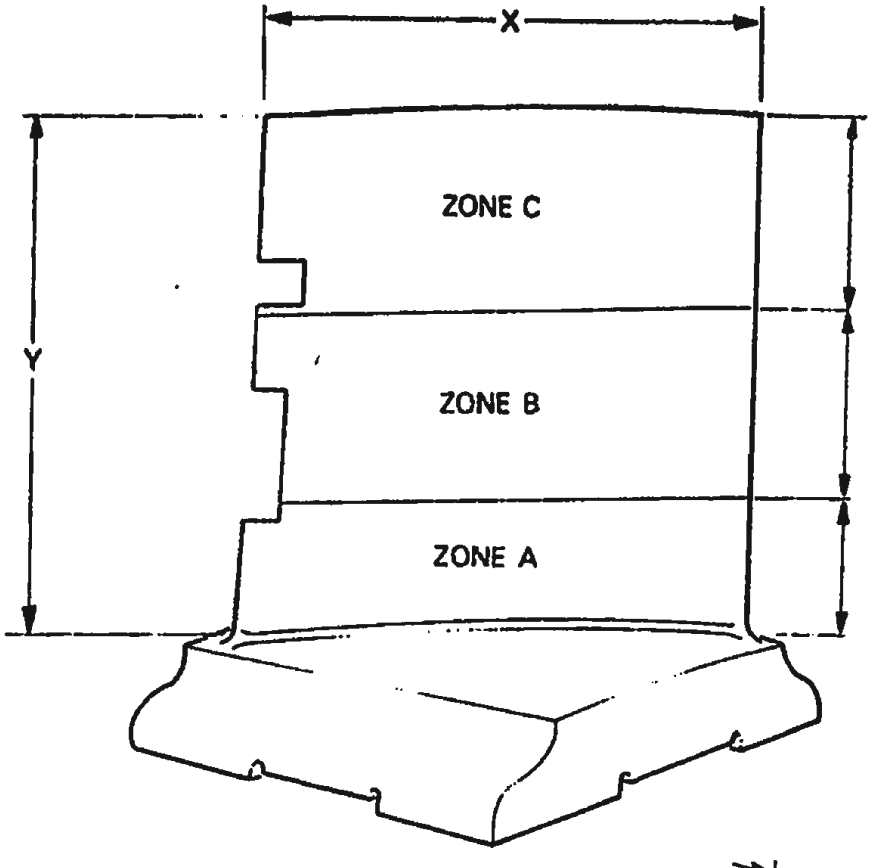
STAGE 5 1.3 in (33.02 mm)
STAGE 6 1.25 in (31.75 mm)

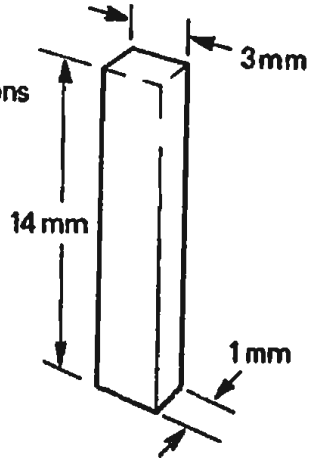
Y The approximate heights of the blades (measured in a straight line at vertical centre-line) are as given

STAGE 5 1.2 in (30.48 mm)
STAGE 6 1.1 in (27.94 mm)

A2511A

R Abutment pad release damage - Typical form of damage
R (Stage 5 H.P. compressor blade trailing edge)
R Fig.601 (Sheet 2)




X The approximate widths of the blades (measured in a straight line at mid-height position) are as given
STAGE 5 1.3 in (33.02 mm)
STAGE 6 1.25 in (31.75 mm)

Y The approximate heights of the blades (measured in a straight line at vertical centre-line) are as given
STAGE 5 1.2 in (30.48 mm)
STAGE 6 1.1 in (27.94 mm)

A2512A

R Abutment pad release damage - Typical form of damage
R (Stage 6 H.P. compressor blade leading edge)
R Fig.601 (Sheet 3)

B. Acceptance Standards - airfoil surfaces

(1) To assist in assessing damage, the dimensions of H.P. compressor blades are given on Fig.601. (Sheet 1)

R R R NOTE: 1. Accept nicks and tears emanating from leading and trailing edges, provided no cracking from damage is evident, up to 0.015in. (0,381 mm.).

R 2. Where damage is evident and encroaches from one zone into another the chord width of the damage in each zone should be assessed against the limit for that particular zone.

(2) Zone A - Damage NOT associated with abutment pad release.

(a) Nicks and/or tears in one edge provided each nick and/or tear does not exceed 10% of the blade chord width.

(b) Cracks in one edge provided the actual length of each crack does not exceed 10% of the blade chord width.

(c) Cracks, nicks and tears in any combination where both edges are affected provided each nick and/or tear does not exceed 5% of blade chord width and the actual length of each crack does not exceed 5% of the blade chord width.

(d) Dents not associated with nicks, cracks or tears.

C C (e) If conditions exceed, (2)(a), (b) or (c), schedule engine change within 25 flight hours.

(3) Zone A - Damage associated with abutment pad release - Engines without S.B.72-9006 only

(a) Stage 5 trailing edge only:
Sharp-edged, hard object damage typical of abutment pad release as shown in Fig.601 (Sheet 2)

(i) Up to 10% of blade chord width with no associated cracking - monitor at intervals of 300 hours maximum.

(ii) If other damage is present on the blade leading edge, the limit for trailing edge damage associated with abutment pad release is restricted to 5% of the blade chord width.

(iii) Damage in excess of the limits in (i) or (ii) above - schedule engine removal within 50 hours or 20 flights whichever is the sooner.

(b) Stage 6 leading edge only:
Sharp-edged, hard object damage typical of abutment pad release as shown in Fig.601 (Sheet 3) - Monitor at intervals of 300 hrs maximum.

NOTE: If this type of damage is observed stage 5 must also be inspected.

(4) Zone B - Damage NOT associated with abutment pad release.

(a) Nicks and/or tears in one edge provided each nick and/or tear does not exceed 10% of the blade chord width.

(b) Cracks in one edge provided the actual length of each crack does not exceed 10% of the blade chord width.

(c) Cracks, nicks and tears in any combination where both edges are affected provided each nick and/or tear does not exceed 5% of blade chord width and the actual length of each crack does not exceed 5% of the blade chord width.

(d) Fly on limits for Zone B cracks, nicks and/or tears.

(i) The limit for Zone B can be extended by up to 50% of the individual limits in (a), (b), (c) above for a maximum of 25 hours or 5 flights whichever is the sooner. This is to enable an operator to accomplish an engine change at base.

C (ii) If condition exceeds (d) (i) contact MCIEE
C before flight.

(e) Dents not associated with nicks, cracks or tears.

R (5) Zone B - Damage associated with abutment pad release -
R Engines without S.B.72-9006 only.

(a) Stage 5 trailing edge only:
Sharp-edged, hard object damage typical of abutment pad release as shown in Fig.601 (Sheet 2)

R (i) Up to 10% of blade chord width with no
R associated cracking - monitor at intervals
R of 300 hours maximum.

R (ii) If other damage is present on the blade
R leading edge, the limit for trailing edge
R damage associated with abutment pad release
R is restricted to 5% of the blade chord width.

R (iii) Damage in excess of the limits in (i) or (ii)
R above - schedule engine removal within 50 hours
R or 20 flights whichever is the sooner.

(b) Stage 6 leading edge only:
Sharp-edged, hard object damage typical of abutment pad release as shown in Fig.601 (Sheet 3) - Monitor at intervals of 300 hrs maximum.

NOTE: If this type of damage is observed stage 5 must also be inspected.

(6) Zone C - Damage NOT associated with abutment pad release.

(a) Nicks and/or tears in one edge provided each nick and/or tear does not exceed 20% of the blade chord width.

(b) Cracks in one edge provided the actual length of each crack does not exceed 20% of the blade chord width.

(c) Cracks, nicks and tears in any combination where one or both edges are affected provided each nick and/or tear does not exceed 10% of blade chord width and the actual length of each crack does not exceed 10% of the blade chord width.

R (d) Fly on limits for Zone C cracks, nicks and/or tears.

R (i) The limit for Zone C can be extended by up to
R 100% of the individual limits in (a), (b), (c)
R above for a maximum of 25 hours or 5 flights
R whichever is the sooner. This is to enable an
R operator to accomplish an engine change at
R base.

CR (ii) If condition exceeds (d) (i) contact MCIEE
CR before flight.

(e) Dents, not associated with cracks, tears and nicks.

(f) Blades with either a detached leading edge tip or trailing edge tip up to approximately 33% chord width, provided that the subsequent stages of blades are examined.

(g) Bending or curling at a blade tip, with associated cracking not exceeding 20% chord width in true length, provided that the subsequent stages of blades are examined.

(h) Heat discolouration associated with tip rubs.

(j) Stage 6 compressor blades only

(i) Radial tip cracks contained within an area extending 33% of chordal width from the trailing edge - Accept.

C (k) If conditions exceed (6) (f), (g) or (j) schedule
C engine change within 25 flight hours.

R (7) Zone C - Damage associated with abutment pad release -
R Engines without S.B.72-9006 only.

(a) Stage 5 trailing edge and stage 6 leading edge: Sharp-edged, hard object damage typical of abutment pad release as shown in Fig.601 (sheets 2 and 3) - Monitor at intervals of 300 hrs maximum.

NOTE: If this type of damage is observed on stage 6 blades, stage 5 blades must be inspected.

(8) Blade material missing from leading/trailing edge.

(a) Without associated cracking provided within the limits of (2)(a)(b)(c), (4)(a)(b)(c) and (6)(a)(b)(c) - Accept.

C. Acceptance Standards - platforms and lockplates

(1) To assist in assessing damage and/or the amount of rearward projection of the stage 6 blade in the stage 6 disc during borescope inspection, the following is given as guidance:

(a) Lockplate sheet material is 0.033in. (0,83 mm.) to 0.039in. (0,99 mm.) thick.

(b) The forging identification mark on the blade platform is contained within a stamped circle approximately 0.10in. (2,54 mm.) diameter.

(c) The stage 6 blade platform front face can be normally located rearward of the disc front face by up to 0.03in. (0,76 mm.).

(d) Blade root edge chamfer is approximately 0.01in. (0,25 mm.).

(e) The stage 6 airfoil leading edge at the platform-to-airfoil blend radius run out is between 0.06in. (1,52 mm.) and 0.08in. (2,03 mm.) from the front edge of the blade platform.

(2) Stage 5

(a) Rearward projection of any blade relative to the stage 5 disc, such that there is evidence of rubbing on the blade rear face or its associated lockplate due to contact with the stage 5 stator assembly - Reject the engine within 50 hours or 20 flight cycles, whichever is the greater.

(3) Stage 6

(a) Any one or more blade platforms located rearwards in excess of 0.10in. (2,54 mm.) from the disc face (the blade platforms should be obviously rearward of the rest in the stage).

(b) The lockplate front tab cracked, rubbed, broken or not bent over.

(c) Reject (a) and (b) within 50 hours or 20 flight cycles, whichever is the greater.

## COMBUSTION SECTION - INSPECTION/CHECK

C NOTE: For Fuel Spray Nozzle - Inspection/Check, Refer to 73-11-06, Inspection/Check.

C 1. Inspect Combustion Section

C A. Using boroscope equipment and procedure (Ref. 72-00-00, Inspection/Check, para.6), inspect combustion section for the following damage:

C (1) Refer to fig.602, inspect outer wall for burning, erosion, cracking and distortion particularly at cooling ring lips.

C (2) Inspect inner wall for burning, erosion, cracking and distortion particularly at cooling ring lips.

C (3) Refer to fig.603, inspect intermediate heat shield segments for loosening (indicated by increased gap between inner and outer flares in relation to adjacent fuel spray nozzles heat shield segments gap) and for burning, erosion, cracking and distortion particularly at louvre corners and around retaining bolts weld.

C (4) CAUTION: THE COMBUSTION LINER SEGMENTS ARE RETAINED BY BOLTS WHICH FEATURE A BLIND HOLE DOWN THE CENTRE OF THE BOLT SHANK. WHEN VIEWED USING BOROSCOPE EQUIPMENT, THE BLIND HOLE WILL APPEAR AS A DARKENED AREA AND MUST NOT BE INTERPRETED AS A MISSING BOLT.
Inspect fuel spray nozzle segments for loosening (indicated by increased gap between inner and outer flares in relation to adjacent intermediate heat shield segments gap) and for burning, erosion, cracking and distortion.

C (5) Inspect mini-flares for burning, erosion, cracking and distortion (Ref. Fig.603).

CR (6) Refer to fig.604, inspect inner wall for cracking at
CR effusion cooling holes.

CR (7) Refer to fig.601, inspect rear inner combustion liner
CR and outer combustion liner cooling lips for burning,
CR erosion, cracking and distortion.

CR For acceptance standards see para.2.

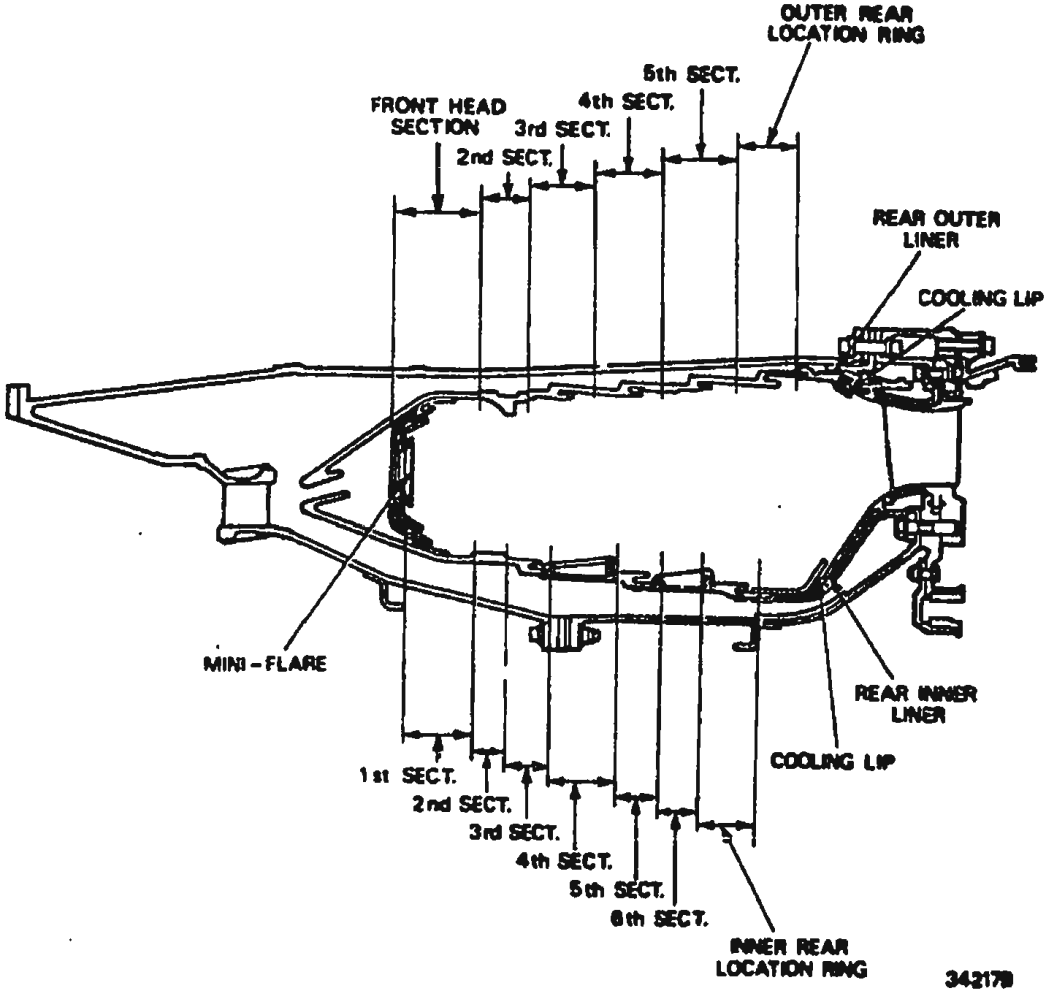
CR B. Inspect Combustion Liners Following Bird Strike

CR Following a known or suspected bird strike into the gas
CR generator, a combustion chamber inspection must be carried
CR out for meter panel distortion and/or bowing as follows:

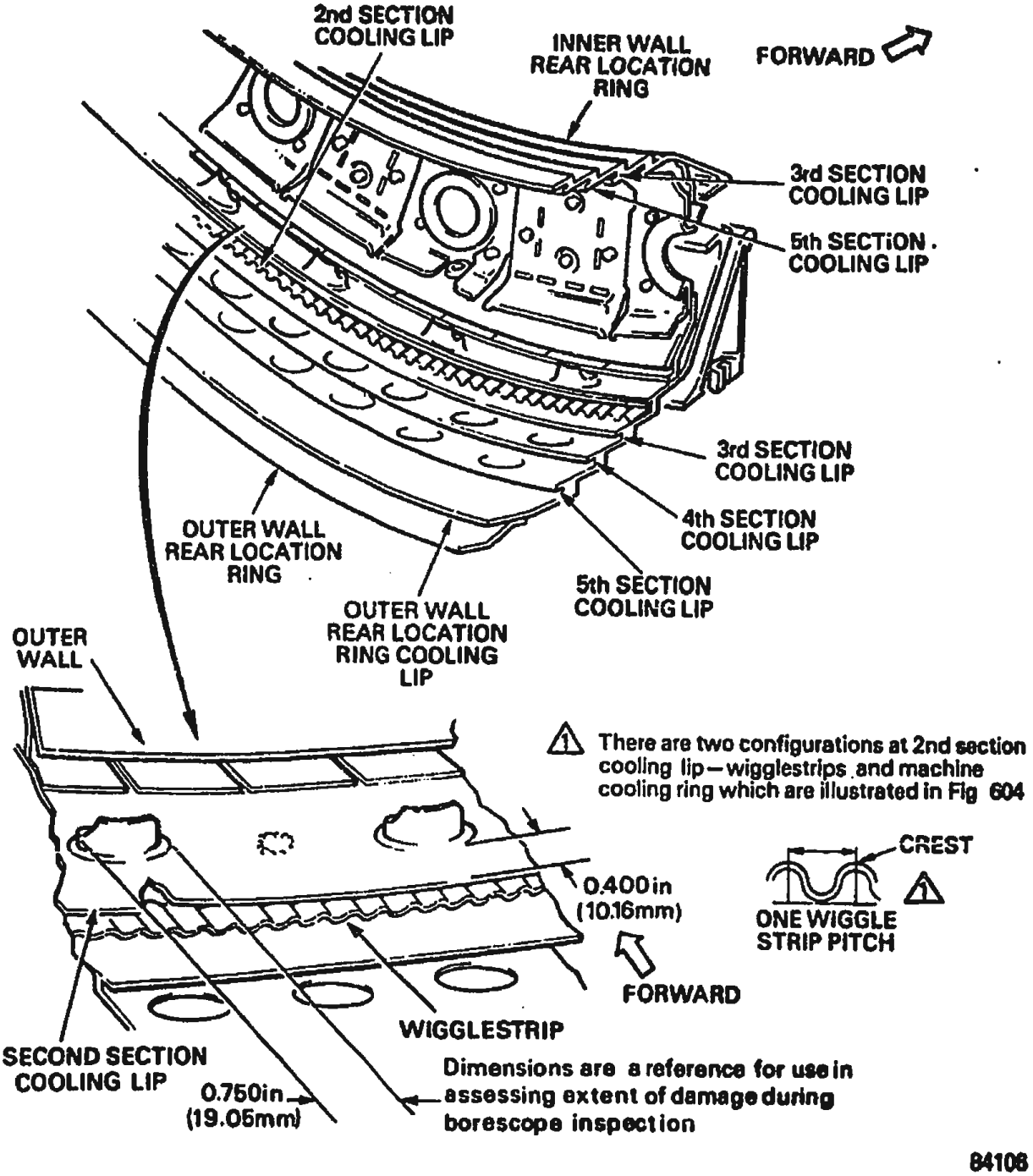
CR (1) Inspect heat shield segments for displacement and/or
CR burning.

CR (2) Inspect fuel spray nozzles for correct location in
CR mini-flares.

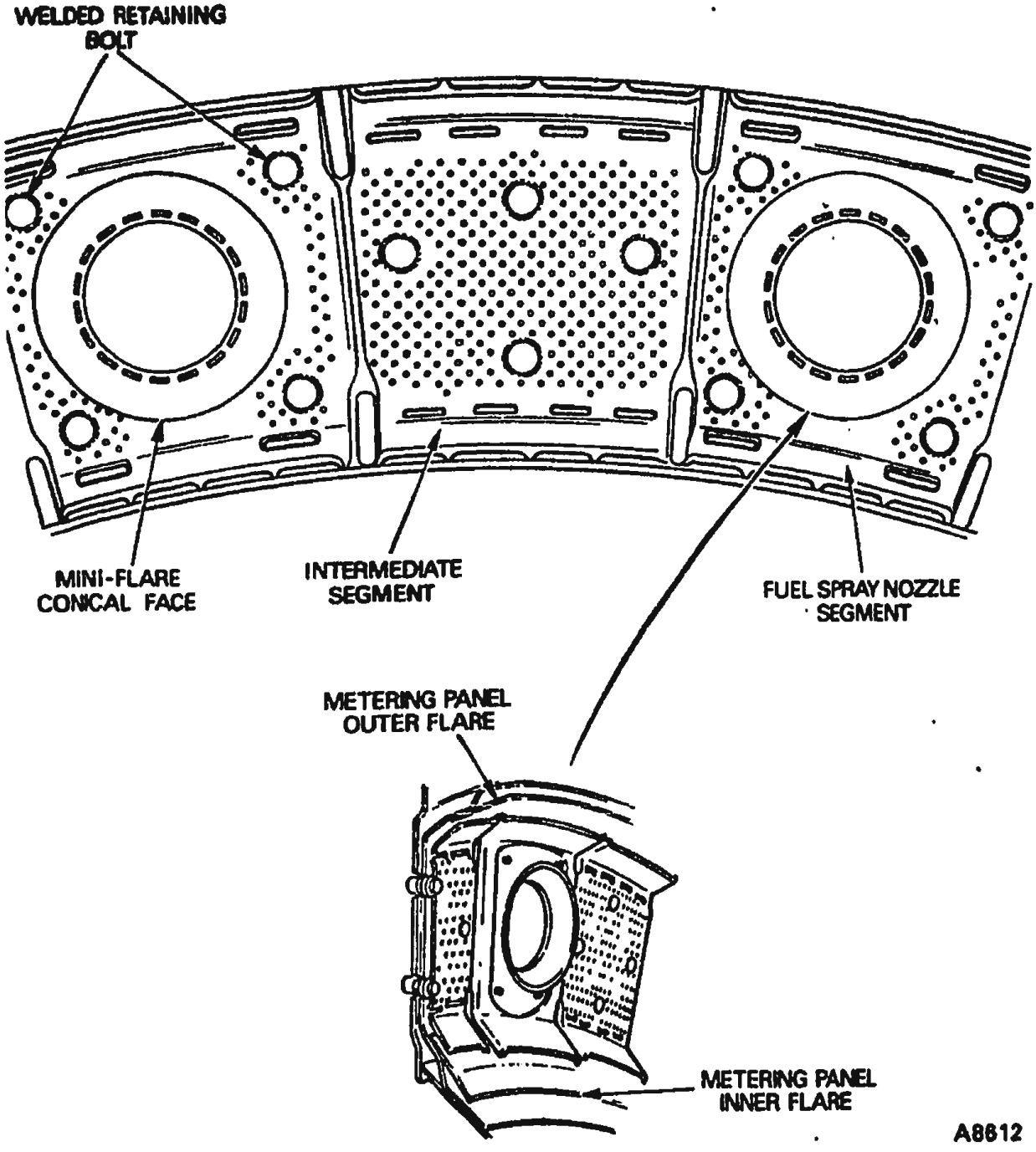
CR For acceptance standards see para.2.



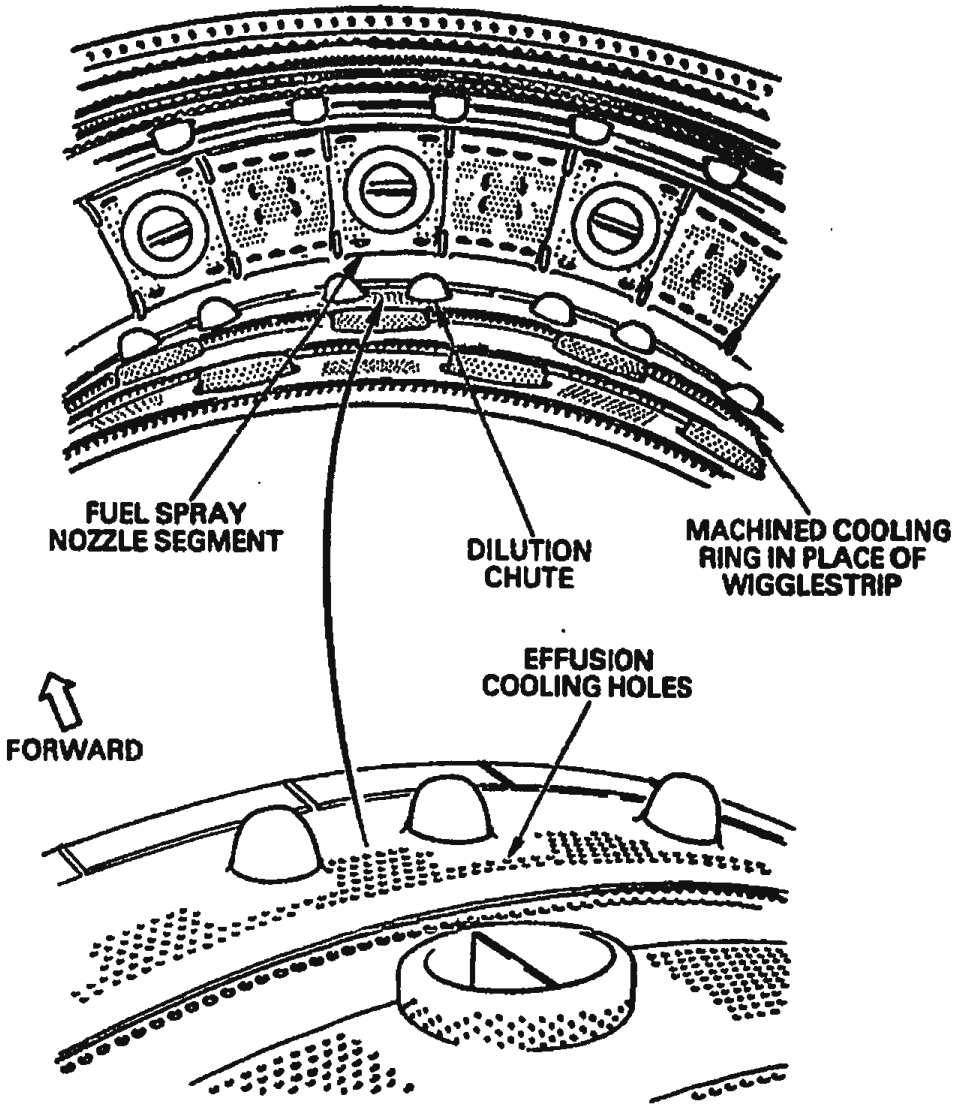

CR Sectional view of combustion chamber
CR Fig.601


2nd SECTION COOLING LIP
INNER WALL REAR LOCATION RING
FORWARD
3rd SECTION COOLING LIP
5th SECTION COOLING LIP
3rd SECTION COOLING LIP
4th SECTION COOLING LIP
5th SECTION COOLING LIP
OUTER WALL REAR LOCATION RING
OUTER WALL REAR LOCATION RING COOLING LIP
OUTER WALL
1 There are two configurations at 2nd section cooling lip—wigglestrips and machine cooling ring which are illustrated in Fig 604
CREST
1
ONE WIGGLE STRIP PITCH
0.400in (10.16mm)
FORWARD
WIGGLESTRIP
SECOND SECTION COOLING LIP
0.750in (19.05mm)
Dimensions are a reference for use in assessing extent of damage during borescope inspection
84108

CR Combustion Liner Outer and Inner Walls Inspection/Check
CR Fig.602




R Combustion Liner Segment Inspection/Check
R Fig.603




84105

CR Effusion cooling holes inspection/check
CR Fig.604

CR 2. Acceptance Standards Combustion Section

CR A. Outer Wall

CR (1) Burning, erosion and distortion of third, fourth, fifth section and outer rear location ring cooling lips (Ref. Fig.602) at any number of positions, providing it does not extend forward more than 0.5in. (12,7 mm.) from cooling lip edge and does not exceed 2.0in. (50,8 mm.) circumferentially.

CR (a) Damage exceeding the above limits is acceptable providing:

CR (i) Rear inner and outer combustion liners and H.P. nozzle guide vanes are reinspected at 250 hour intervals as per M11-72-07.

CR (2) Radially inward distortion of the second section cooling lip (Ref. Fig.602) up to 0.30in. is acceptable.

CR (a) The following damage is acceptable provided that re-inspection is carried out within 500 hours.

CR (i) Second section cooling lip axial cracking resulting in second section wall protrusion into the gas stream provided this does not exceed 0.30in. (7,62 mm.) at not more than 12 positions.

CR (b) Further wigglestrip unzip/cracking is acceptable provided that re-inspection is carried out within 250 hours.

CR (i) Second section cooling lip axial cracking resulting in second section wall protrusion into gas stream not exceeding 0.30in. (7,62 mm.) at up to 24 positions.

CR (c) When second section cooling lip axial cracking resulting in second section wall protrusion into gas stream not exceeding 0.30in. at over 24 positions, schedule engine change within 25 hours.

CR (d) Any wall protrusion greater than 0.30in. and less than 0.50in. is acceptable if reinspected within 250 hours.

CR (e) If wall protrusion is over 0.50in., schedule
CR engine change within 25 hours.

CR (3) Burning and/or cracking which causes holes or loss of
CR material at a maximum of four positions provided that:

CR (a) Area of any hole does not exceed 1.00 sq.in. is
CR acceptable.

CR (b) Area of any hole exceeding 1.00 sq.in. but less
CR than 2.00 sq.in. providing engine is reinspected
CR within 250 hours.

CR (c) Area of any hole exceeding 2.00 sq.in. - schedule
CR engine removal within 25 hours providing:

CR (4) Axial cracking of the third, fourth, fifth section and
CR outer rear location ring cooling lips (Ref. Fig.602) at
CR any number of positions, providing it does not extend
CR forward more than 1.0in. from cooling lip edge. If
CR cracking exceeds 1.0in., reinspect within 250 hours.

CR (5) Axial cracking from rear of outer secondary dilution
CR chute to the edge of the second section cooling lip at
CR a maximum of 10 positions is acceptable. For 10 to 15
CR positions, reinspect within 250 hours. For over 15
CR positions, schedule engine change within 25 hours.

CR (6) Two-inch circumferential cracks between dilution
CR chutes are acceptable. Circumferential cracking up
CR to full length between two dilution chutes at three
CR positions (if adjacent sections are sound and positions
CR are separated by at least three dilution chutes)
CR reinspect within 250 hours. Cracking in excess requires
CR scheduling an engine change within 25 hours.

CR (7) Single or multiple cracking of the secondary dilution
CR chutes is acceptable.

CR (8) Burning and/or erosion of secondary dilution chutes.

CR (a) In-service limit - Burning and/or erosion of one or
CR more dilution chutes less than 75 percent is
CR acceptable.

C (b) Recheck limit (250 hours) - Burining and/or erosion of one or more dilution chutes greater than 75 percent or total loss of dilution chute providing: M11-72-07 is scheduled at 250 hour intervals.

R (9) Loss of thermal barrier coating.

R (a) A loss of thermal barrier coating is acceptable

C B. Inner Wall

C (1) Burning, erosion and distortion of third, fourth, fifth section and inner rear location ring cooling lips (Ref. Fig.602) at any number of positions, providing it does not extend forward more than 0.5in. (12,7 mm.) from cooling lip edge and does not exceed 2.0in. (50,8 mm.) circumferentially.

C (a) Damage exceeding the above limits and up to 1.0in. from edge reinspect within 250 hours. Damage over 1.0in. from edge and over 2.0in. circumferentially requires engine change within 25 hours.

C (2) Burning and/or cracking which causes holes or loss of material at no more than nine positions provided that:

C (a) Area of any hole does not exceed 0.50 sq.in. (161,3 sq.mm.) is acceptable.

C (b) Area of any hole exceeding 0.50 sq.in. but less than 2.00 sq.in. reinspect at 250 hour intervals.

C (c) Area of any hole exceeding 2.00 sq.in., schedule engine change within 25 hours.

C (3) Axial cracking of third or fifth section cooling lips (Ref. Fig.602) at any number of positions is acceptable.

C (4) Axial cracking of the inner rear location ring cooling lip (Ref. Fig.602) at any number of positions is acceptable.

C (5) Single or multiple cracking of the secondary dilution chutes is acceptable.

C (6) Burning and/or erosion of secondary dilution chutes.

C (a) In-service limit - Burning and/or erosion of one or more dilution chutes less than 75 percent is acceptable.

C (b) Recheck limit (250 hours) - Burning and/or erosion of one or more dilution chutes greater than 75 percent of total loss of dilution chute providing: M11-72-07 is scheduled at 250 hour intervals.

R (7) Loss of thermal barrier coating.

R (a) A loss of thermal barrier coating is acceptable.

C C. Inner and Outer Flares (Ref. Fig.603)

C (1) Burning, erosion and loss of material of the inner or outer flare at any number of positions is acceptable.

C (2) Axial cracking providing no circumferential cracking is evident.

C D. Intermediate Heat Shield Segments (Ref. Fig.603)

C (1) Cracks emanating from the intermediate heat shield slots and running through effusion cooling holes, providing no piece is about to be released, is acceptable.

(2) Cracking/burning of heatshield segment retaining bolts weld at a maximum of 2 positions per heatshield is acceptable provided:

(a) Not more than 50 per cent of weld is affected

(b) Re-inspection is carried out within 250 hours.

(3) Cracking/burning in excess of (2) is acceptable but must not affect more than 3 positions per heatshield and re-inspection must be carried out within 130 hours.

(4) Cracking/burning in excess of (3) is acceptable but must be re-inspected within 65 hours.

C (5) One retaining bolt missing (indicated by a larger hole than the blind hole in the retaining bolt shank) is acceptable, providing H.P. nozzle guide vanes and H.P. turbine blades are inspected (Ref. 72-53-00, Inspection/Check), and that any damage to H.P. nozzle guide vanes and H.P. turbine blades is within limits.

C (6) If two retaining bolts missing, schedule engine removal within 25 hours providing H.P. nozzle guide vanes and H.P. turbine blades are inspected and within limits.

C (7) If a heat shield segment is missing, schedule engine removal within 25 hours providing H.P. nozzle vanes and H.P. turbine blades are inspected and within limits.

C (8) If a heat shield segment has become detached and remains in the combustion liner, reject the engine.

C (9) A loose heat shield (indicated by increased gap between inner and outer flares in relation to adjacent fuel spray nozzle heat shield segments gap) requires an engine change within 25 hours.

(10) Burning and/or erosion of heatshield segment inner or outer flares is acceptable provided metering panel inner and outer flares are within accceptance limits in para. 2.C.

(11) Individual cracks propagating to edges of heatshield segment inner and outer flares are acceptable provided cracks are a minimum of 0.25in. (6,35mm.) apart.

C E. Fuel Spray Nozzle Segments (Ref. Fig.603)

C (1) Cracks/burning of retaining bolts weld at any one position per spray nozzle segment, providing there is no loss of retaining bolt locking, is acceptable.

C (2) Cracks/burning or loss of retaining bolt locking weld fillet, indicating loss of bolt shank locking is acceptable. Reinspect at 250 hour interval.

C (3) One retaining bolt missing (indicated by a larger hole than the blind hole in the retaining bolt shank) is acceptable, providing H.P. nozzle guide vanes and H.P. turbine blades are inspected (Ref. 72-53-00, Inspection/Check), and that any damage to H.P. nozzle guide vanes and H.P. turbine blades is within limits.

C (4) If two retaining bolts missing, schedule engine removal within 25 hours, providing H.P. nozzle guide vanes and H.P. turbine blades are inspected and within limits.

C (5) A loose heat shield (indicated by increased gap between inner and outer flares in relation to adjacent intermediate heat shield segments gap) requires an engine change within 25 hours.

C (6) Burning and/or erosion of mini-flare is acceptable.

C (7) Multiple cracking across the complete width of the mini-flare conical face providing not more than one crack runs into any one slot, is acceptable.

C (8) Local distortion of the conical face is acceptable.

C (9) If a mini-flare is missing, schedule engine removal within 25 hours, providing H.P. nozzle guide vanes and H.P. turbine blades are inspected and within limits.

C (10) If a mini-flare has become detached and remains in the liner, reject engine.

(11) Burning and/or erosion of fuel spray nozzle segment inner or outer flares is acceptable provided metering panel inner and outer flares are within acceptance limits in para 2.C.

(12) Individual cracks propagating to edges of fuel spray nozzle segment inner and outer flares are acceptable provided cracks are a minimum of 0.25in. (6,35mm.) apart.

C F. Rear Inner Combustion Liner (Ref. Fig.601)

C (1) Burning, erosion, axial cracking and/or distortion of rear inner combustion liner cooling lip is acceptable.

C (2) Circumferential cracking of the cooling lip, providing it does not exceed 3.0in. in length is acceptable.

C (3) Circumferential cracking of the cooling lip exceeding 3.0in. but less than 10.0in. in length and 50% of circumference remains intact - inspect within 250 hours.

C (4) Circumferential cracking of the cooling lip exceeding 10.0in. requires an engine change within 25 hours.

C (5) Circumferential cracking rear of lip less than 10.0in. in length, if 50% of circumference is intact, is acceptable. Cracking 10.0in. to 20.0in. requires reinspection within 250 hours. Cracking over 20.0in. requires engine change within 25 hours.

R (6) A loss of thermal barrier coating is acceptable

C G. Rear Outer Combustion Liner (Ref. Fig.601)

C NOTE: Liner circumference is 106.0 inches.

C (1) Burning, erosion, axial cracking and/or distortion of rear inner combustion liner cooling lip is acceptable.

C (2) Circumferential cracking of cooling lip, providing no single crack exceeds 6.0in. in length, is acceptable.

C (3) Circumferential cracking of cooling lip or rear of the cooling lip exceeding 6.0in., but less than 21.0in. in length, providing the accumulative length of all cracks does not exceed 50 per cent of the liner circumference - reinspect within 250 hours.

C (4) Single cracks or an accumulation of cracks which exceed 50 per cent of the accumulation of the liner - schedule engine removal within 25 flight hours.

R (5) A loss of thermal barrier coating is acceptable

3. Inspect Combustion Outer Case

A. Inspection of the combustion outer case is non-routine and should be carried out on an opportunity basis or if a crack is suspected.

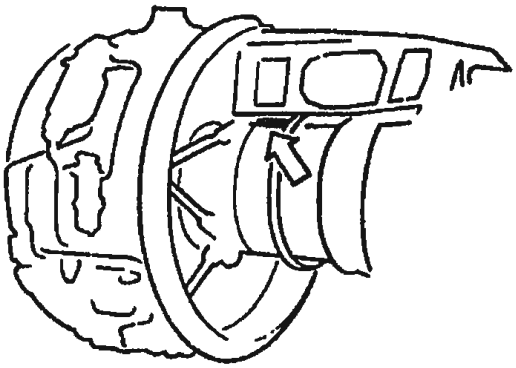
(1) Inspect for cracking of weld between H.P. air offtake soleplate and adjacent fuel spray nozzle soleplates (refer fig.605).

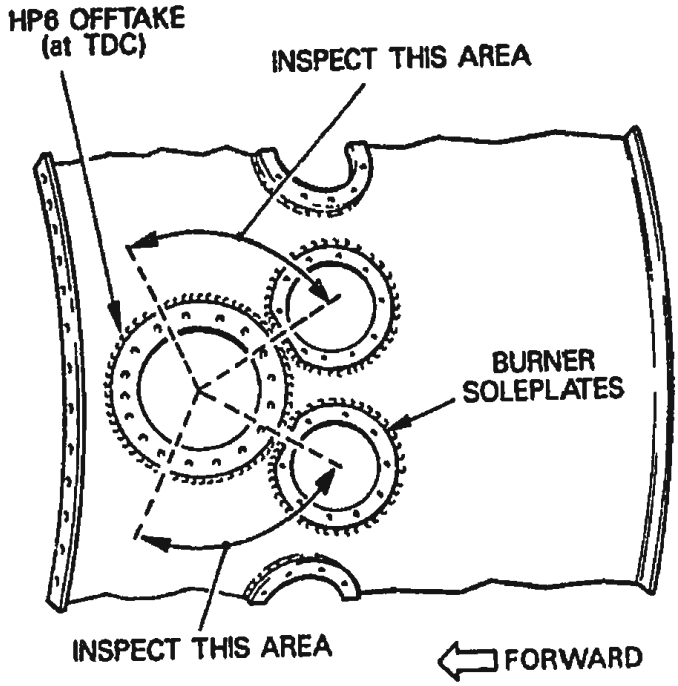
B. Acceptance standards of combustion outer case

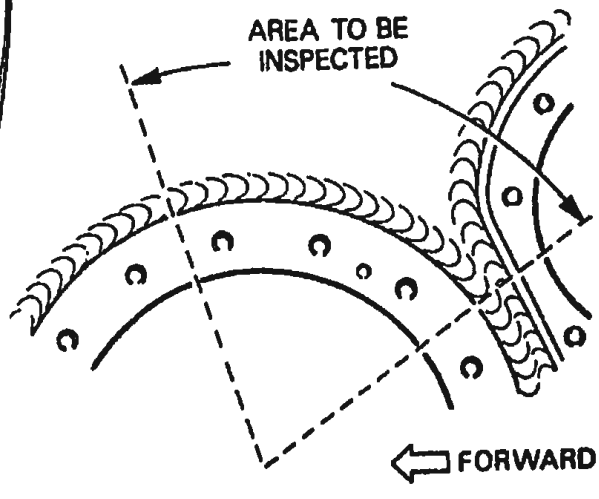
(1) Cracks less than 0.50in. (12,7 mm.) - Re-inspect within 100 flight cycles.

(2) Cracks greater than 0.50in. (12,7 mm.) but less than 1.50in. (38,1 mm.) - Re-inspect within 50 flight cycles.

(3) Cracks in excess of 1.50in. (38,1 mm.) - Reject engine.






A6552

Combustion Outer Case - Inspection/Check
Fig.605

R (4) If 2 retaining bolts missing, inspect H.P. nozzle guide vanes and H.P. turbine blades (Ref. 72-00-00, Inspection/Check, para's.6 and 7); providing any damage to H.P. nozzle guide vanes and H.P. turbine blades is acceptable - Schedule engine removal within 30 hours.

R (5) A loose heat shield (indicated by increased gap between inner and outer flares in relation to adjacent intermediate heat shields segments gap) CR is not acceptable - Schedule engine removal within CR 30 hours.

R (6) Burning and/or erosion of mini-flare extending from the periphery of the conical section and not exceeding R 75% of conical face width.

R (a) Damage exceeding the above limits in acceptable R provided:

R (i) Inner and outer flares and fuel spray nozzle R segments are inspected and any damage does not R exceed limits given in para's.C. and E.

R (ii) Inner and outer walls and rear combustion R liners are inspected and any damage is within R limits given in para's.A., B., F., and G.

R (iii) H.P. nozzle guide vanes are inspected as R detailed (Ref. 72-00-00, Inspection/Check, R para.6) and any damage does not exceed limits R (Ref. 72-53-00, Inspection/Check).

R (iv) The areas stated above are re-inspected R within 130 hours intervals.

R (7) Multiple cracking across the complete width of the R mini-flare conical face providing not more than one R crack runs into any one slot.

R (8) Local distortion of the conical face.

R (9) If a mini-flare is missing, inspect H.P. nozzle guide R vanes and H.P. turbine blades (Ref. 72-00-00, R Inspection/Check, para's.6 and 7); providing any damage R to H.P. nozzle guide vanes and H.P. turbine blades is R within limits - Schedule engine removal within 15 hours.

R (10) If a mini-flare has become detached and remains in
R the liner - Reject engine.

R (11) Any fuel spray nozzle not located in mini-flare -
R Reject engine.

R NOTE: *Provided replacement fuel spray nozzle locates*
R *correctly within mini-flare and that borescope*
R *inspection of H.P. N.G.V. and H.P. turbine*
R *section is satisfactory - Continue in service.*

R F. Rear Inner Combustion Liner (Ref. fig.601)

R (1) Burning, erosion, axial cracking and/or distortion of
R rear inner combustion liner cooling lip.

R (2) Circumferential cracking of the cooling lip, providing
R it does not exceed 1.0in. (25,4 mm.) in length.

R (3) Circumferential cracking of the cooling lip exceeding
R 1.0in. (25,4 mm.) but less than 3.0in. (76,2 mm.) in
R length - Re-inspect within 250 hours.

R (4) Circumferential cracking of the cooling lip exceeding
R 3.0in. (76,2 mm.) but less than 6.0in. (152,4 mm.)
R in length, providing there is no axial cracking -
R Re-inspect within 130 hours.

R (5) Circumferential cracking in excess of (4) - Schedule
R engine removal within 30 hours.

R (6) Circumferential cracking of the rear inner combustion
R liner, rear of the cooling lip, not exceeding 10.0in.
R (254,0 mm.) in length.

R (7) Circumferential cracking in excess of (6) exceeding
R 10.0in. (254,0 mm.) in length - Schedule engine removal
R within 65 hours.

R G. Rear Outer Combustion Liner (Ref. fig.601)

R (1) Circumferential cracking of cooling lip providing
R it does not exceed 1.0in. (25,4 mm.) in length.

(2) Circumferential cracking of cooling lip exceeding 1.0in. (25,4 mm.) but less than 3.0in. (76,2 mm.) in length - Re-inspect within 250 hours.

(3) Circumferential cracking of cooling lip exceeding 3.0in. (76,2 mm.) but less than 10.0in. (254,0 mm.) in length, providing there is no associated axial cracking - Re-inspect within 130 hours.

C C C (4) Single cracks or an accummulation of cracks which exceeds 50 per cent of the accummulation of the limits - Schedule engine removal within 25 hours.

CR CR (5) Contents of paragraphs G (5) and (6) deleted at operators request (LASC CIC2312 TW 29.1.91).

3. Inspect Combustion Outer Case

A. Inspection of the combustion outer case is non-routine and should be carried out on an opportunity basis or if a crack is suspected.

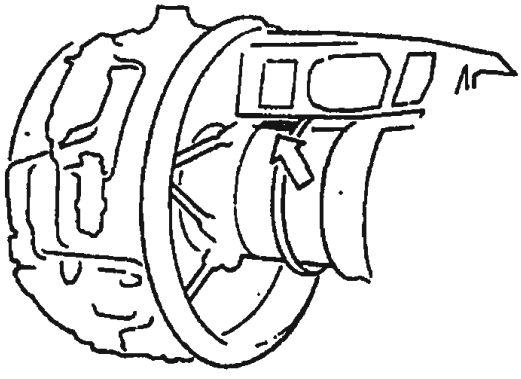
(1) Inspect for cracking of weld between H.P. air offtake soleplate and adjacent fuel spray nozzle soleplates (refer fig.605).

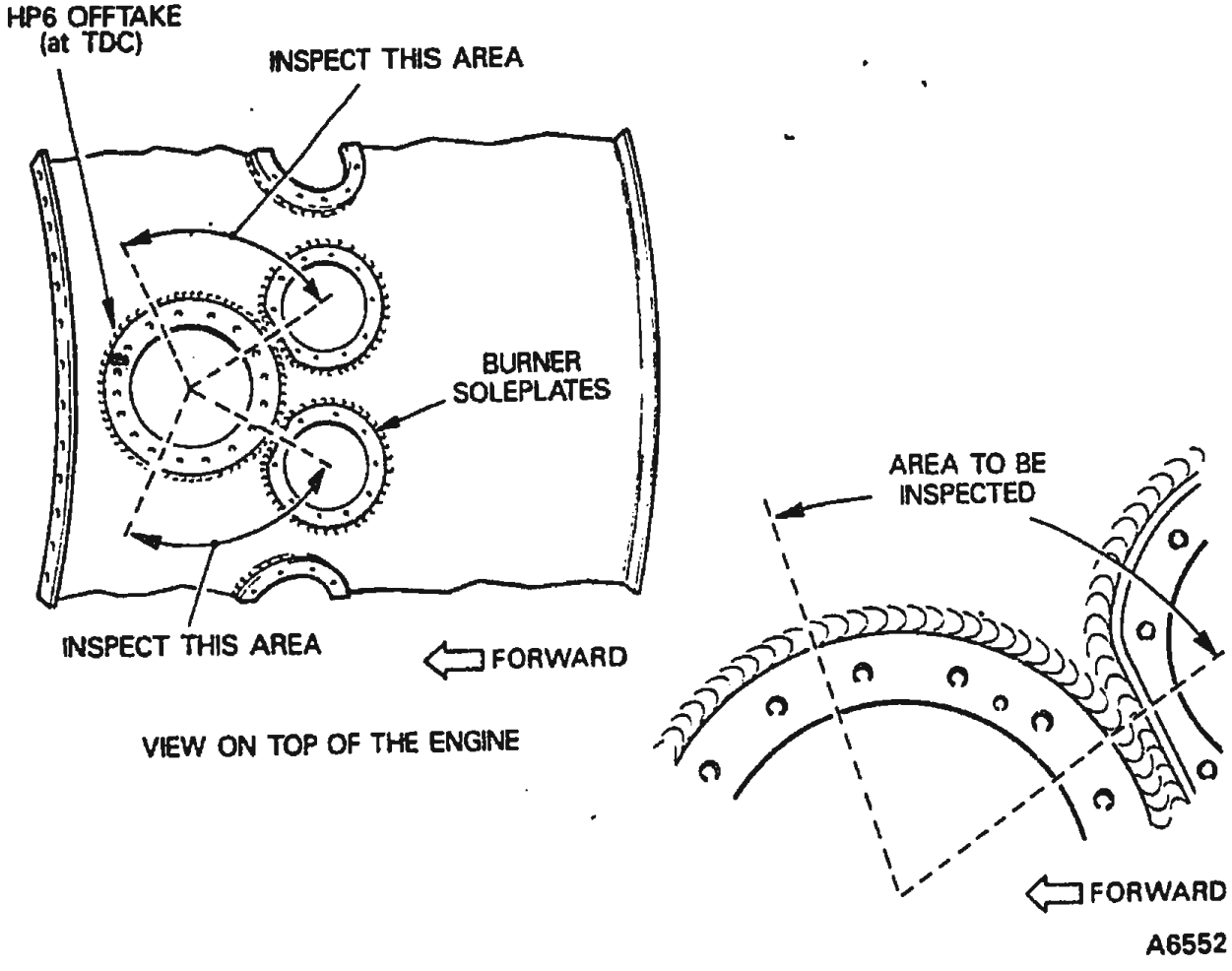
B. Acceptance standards of combustion outer case

(1) Cracks less than 0.50in. (12,7 mm.) - Re-inspect within 100 flight cycles.

(2) Cracks greater than 0.50in. (12,7 mm.) but less than 1.50in. (38,1 mm.) - Re-inspect within 50 flight cycles.

(3) Cracks in excess of 1.50in. (38,1 mm.) - Reject engine.






R Combustion Outer Case - Inspection/Check
R Fig.605

## LOW PRESSURE (L.P.) TURBINE - INSPECTION/CHECK

### 1. Inspect L.P. Turbine Blades and Stage 1 L.P. turbine Lockplates

A. Inspection

CR CR (1) Re-inspection intervals may be extended at operators discretion.

(2) Using borescope equipment and procedures (Ref. 72-00-00, Inspection/Check, para.7) inspect for following damage:

(a) Leading edge of L.P. turbine blades for cracks and foreign object damage.

(b) Trailing edge of L.P. turbine blades for cracks and foreign object damage.

(c) Airfoil surfaces of L.P. turbine blades for cracks and foreign object damage.

(d) Record gap sizes between all stage 1 L.P. turbine blade lockplates

NOTE: This is carried out when inspecting rear surface of stage 1 L.P. turbine blades.

For acceptance standards see para.B.

B. Acceptance Standards

NOTE: To assist in assessing damage, the dimensions of L.P. turbine blades are given on fig.601.

CR CR (1) Cracks within 0.5in. (12,7 mm.) of blade root are not acceptable.

(2) Damage within the following limitations is acceptable.

(a) Leading edge

C (i) Smooth bottomed dents.

(b) Trailing edge

C (i) Cracks up to .25 in. (6,35 mm.) long, not more
C than two per blade provided they are one inch
C apart.

C (ii) Smooth bottomed dents.

(iii) A maximum of two cracks associated with damage in para. (ii) not exceeding 0.25in. (6,35 mm.) in length, with a minimum of 1.5in. (39,1 mm.) between cracks and providing they are not axially in-line with any leading edge damage - Re-inspect at 300 hour intervals.

(c) Airfoil surfaces

C (i) Smooth bottomed dents.

C (ii) Nicks and scratches providing there are no
C associated cracks.

(iii) Foreign object spatter.

CR (iv) Conditions in excess of (i), (ii), (iii)
CR require engine removal within 25 hours.

(d) Stage 1 L.P. turbine blade lockplates

(i) A total cumulative gap between all lockplates not exceeding 0.5in. (12,7 mm.) or a total cumulative gap between any three adjacent lockplates not exceeding 0.30in. (7,62 mm.) is acceptable.

## 2. Inspect Stage 2 and 3 L.P. Turbine Nozzle Guide Vanes

A. Inspection

(1) Gain access to exhaust unit and using inspection lamp inspect trailing edge of stage 3 and as far as possible, stage 2 L.P. turbine nozzle guide vanes for following damage:

(a) Dents and nicks

(b) Cracks and foreign object damage

For acceptance standards see para.B.

B. Acceptance Standards

(1) Cracks or tears within 0.5in. (12,7 mm.) of inner and outer vane platforms are not acceptable.

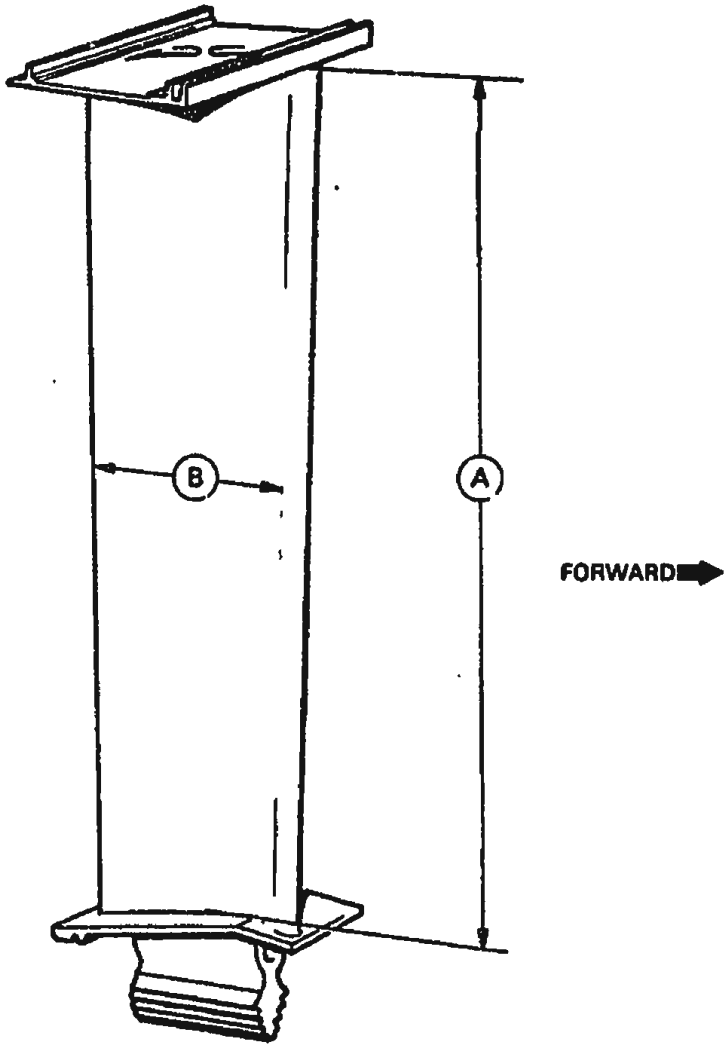
(2) Axial cracks are not acceptable.

(3) Dents or nicks, providing they do not penetrate vane

(4) Damage to trailing edge of vane providing it is within 0.5in. (12,7 mm.) of trailing edge.

(5) Cracks, providing they are non-convergent, do not exceed 1.0in. (25,4 mm.) in length and a minimum of 1.0in. (25,4 mm.) between cracks.

R If conditions exceed B.(1), (2), (3), (4) or (5),
R schedule engine change within 25 flight hours.




(A) The approximate heights of the blades (at vertical centre-line) are as follows:-

Stage 1 6·0 ins.
Stage 2 8·5 ins.
Stage 3 9·8 ins.

(B) The approximate widths of the blades (at mid-height position) are as follows:-

Stage 1 1·5 ins.
Stage 2 1·9 ins.
Stage 3 2·1 ins.

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R L.P. turbine blade, inspection/check
R Fig.601

R L.P. TURBINE BEARING SUPPORT ASSEMBLY - REMOVAL/INSTALLATION

R 1. L.P. Turbine P8 Rake Tube to P8 Manifold-Removal/Installation

R Referenced Procedures:

R 70-51-00 Torque Tightening Technique.
R 72-03-00 Gas Generator Fairings - Removal/Installation.
R 78-30-00 Thrust Reverser - Servicing.

R Illustrated Parts Catalogue References:

R The I.P.C. sections where parts disturbed during the following
R operations can be located are as follows:

R 72-51-03 L.P. Turbine Bearing Support.
R 77-11-05 P8 Rake and Manifold.

R Service Bulletins referred to:

R S.B.72-5221 - P8 connectors flexibly mounted

R A. Remove P8 Rake Tube (Engines without S.B.72-5221)

R (1) Equipment required.

R 289200 or C4G4342 Protective work mats.

R (2) WARNING: ENSURE THRUST REVERSER IS LOCKED IN FORWARD
R THRUST POSITION WHILE WORK IS IN PROGRESS
R Deactivate and tag thrust reverser and associated
R systems, fit thrust reverser locks (Ref.78-30-00).

R (3) Position protective work mats in cold stream duct.

R (4) Enter cold stream duct and remove the following gas
R generator fairings (Ref.72-03-00).

R (a) Engine No.1 and 3.

R Turbine Section Lower Fairing 417A or 427A
R Turbine Section L.H. Fairing 416BL or 426BL
R Turbine Section R.H. Fairing 416BR or 426BR

R (b) Engine No.2

R Turbine Section Lower Fairing 437A
R Turbine Section L.H. Fairing 436BL
R Turbine Section R.H. Fairing 436BR

R (5) Refer to fig.401 (Sheet 1), remove bolt (1) then
R disconnect and remove tube (2).

R (6) Remove bolt and washer (3), then remove bolt (4).

R (7) Slacken bolt (5) then disconnect and remove tube (6)
R moving bracket (7) to give clearance.

R (8) Remove bolt and washer (8) then remove bolt (9).

R (9) Slacken bolt (10) then disconnect and remove tube (11)
R moving bracket (12) to give clearance.

R (10) Refer to fig.401 (Sheet 2), remove bolt (1) then
R disconnect and remove tube (2).

R (11) Remove bolt and washer (3) then remove bolt (4).

R (12) Slacken bolt (5) then disconnect and remove tube (7)
R moving bracket (6) to give clearance.

R B. Remove P8 Rake tube (Engines with S.B.72-5221)

R (1) Equipment required:

| | |
|---|---|
| R 289200 or C4G4342 | Protective work mats |
| R HU20827 | Extractor |
| R HU20828 | Replaceable jaws |

R (2) WARNING: ENSURE THRUST REVERSER IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS
Deactivate and tag thrust reverser and associated systems, fit thrust reverser locks (Ref. 78-30-00).

R (3) Position protective work mats in cold stream duct.

R (4) Enter cold stream duct and remove the following gas generator fairings (Ref. 72-03-00).

R (a) Engine No.1 and 3.

R Turbine Section Lower Fairing 417A or 427A
R Turbine Section L.H. Fairing 416BL or 426BL.
R Turbine Section R.H. Fairing 416BR or 426BR.

R (b) Engine No.2

R Turbine Section Lower Fairing 437A
R Turbine Section L.H. Fairing 436BL
R Turbine Section R.H. Fairing 436BR

R (5) Refer to fig.402 (Sheet 1), remove bolts (1), remove pin (2) using extractor and jaws then remove bracket (3). Disconnect and remove tube (4).

R (6) Disconnect clip (8) from bracket (6).

R (7) Remove bolts (5) and bracket (6) then disconnect and remove tube (9).

R (8) Refer to fig.402 (Sheet 2), remove bolts (1), remove pin (2) using extractor and jaws then remove bracket (3). Disconnect and remove tube (4).

R (9) Disconnect clip (7) from bracket (9).

R (10) Remove bolts (8) and bracket (9) then disconnect and remove tube (6).

R (11) Disconnect clip (13) from bracket (11).

R (12) Remove bolts (12) and bracket (11) then disconnect
R and remove tube (10).

R C. Install P8 Rake Tube (Engines without S.B.72-5221)

R (1) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Lockwire | DTD189A 22 S.W.G. | - 21 A.W.G. | 238 |

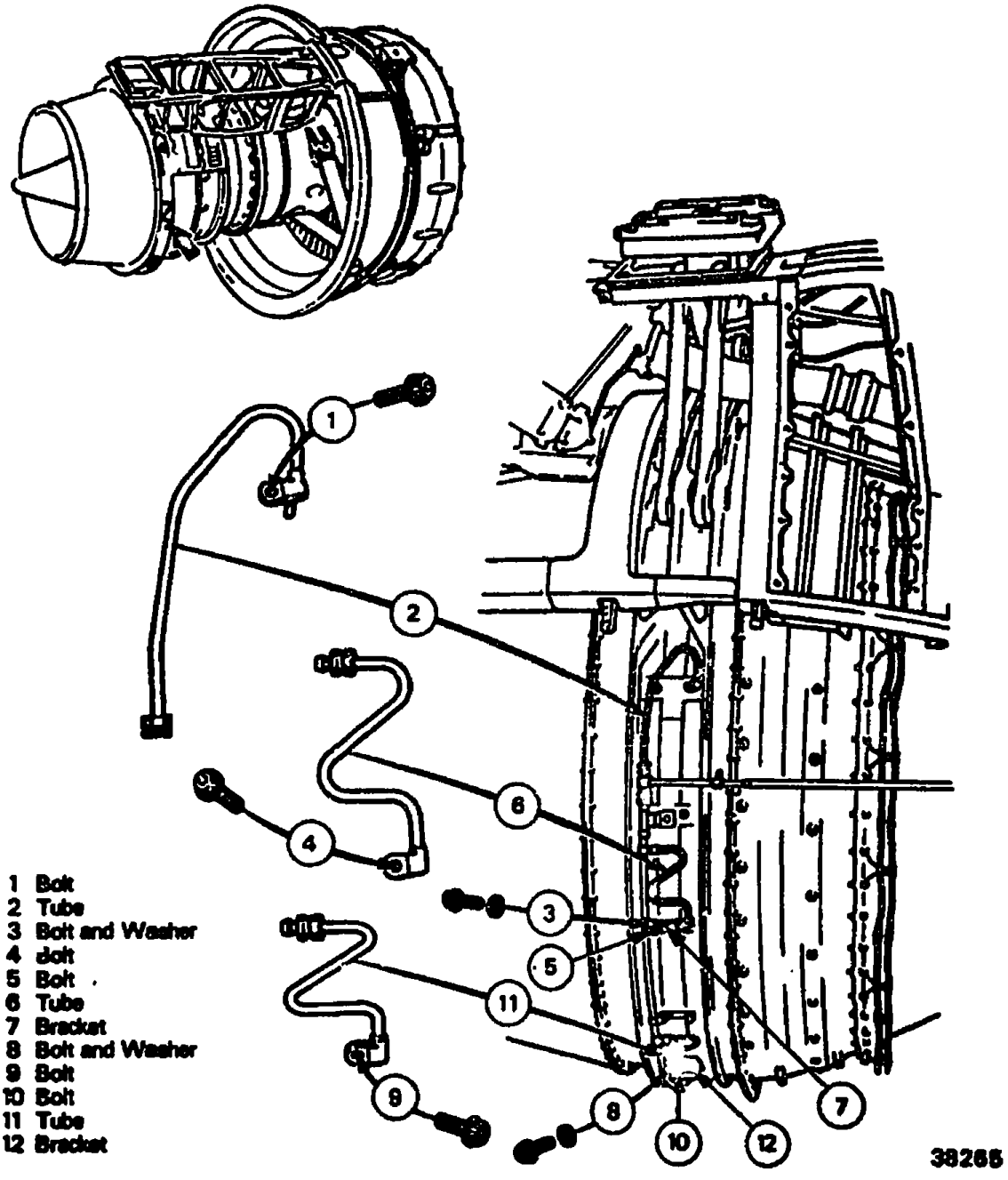
R (2) Ensure thrust reverser locks fitted, operation A.(2).

R (3) Ensure protective work mats positioned in cold
R stream duct.

R (4) Refer to fig.401 (Sheet 2), move bracket (6) to give
R clearance, install tube (7) then fit bolt (4) ensuring
R bracket (6) is positioned correctly.

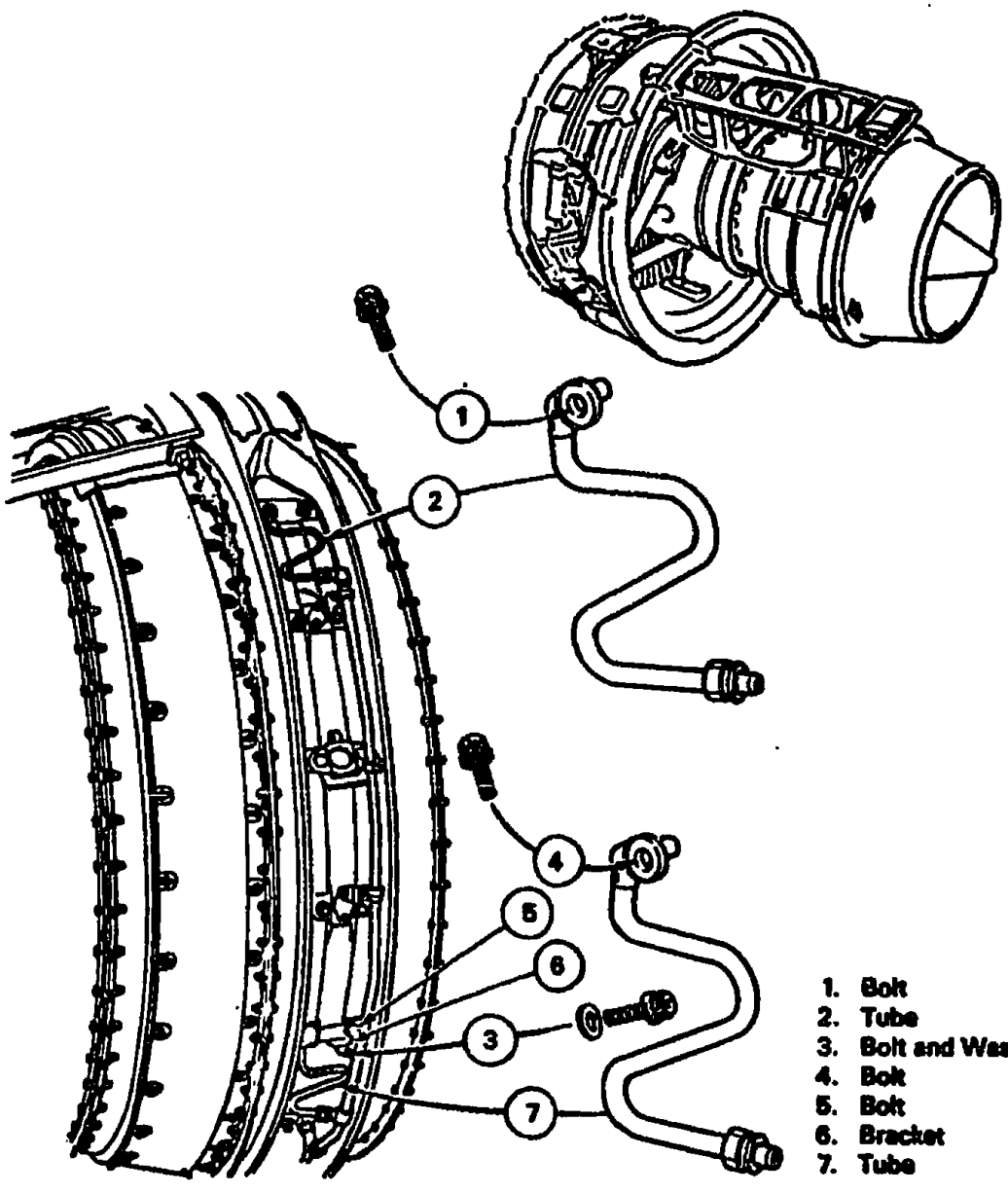
R (5) Connect and secure (Ref.70-51-00) tube (7) then
R wirelock.

R (6) Tighten bolts (4) and (5), then fit and secure bolt
R and washer (3).




R P8 rake tube - removal/installation
R (Engines without S.B.72-5221)
R Fig.401 (Sheet 1)

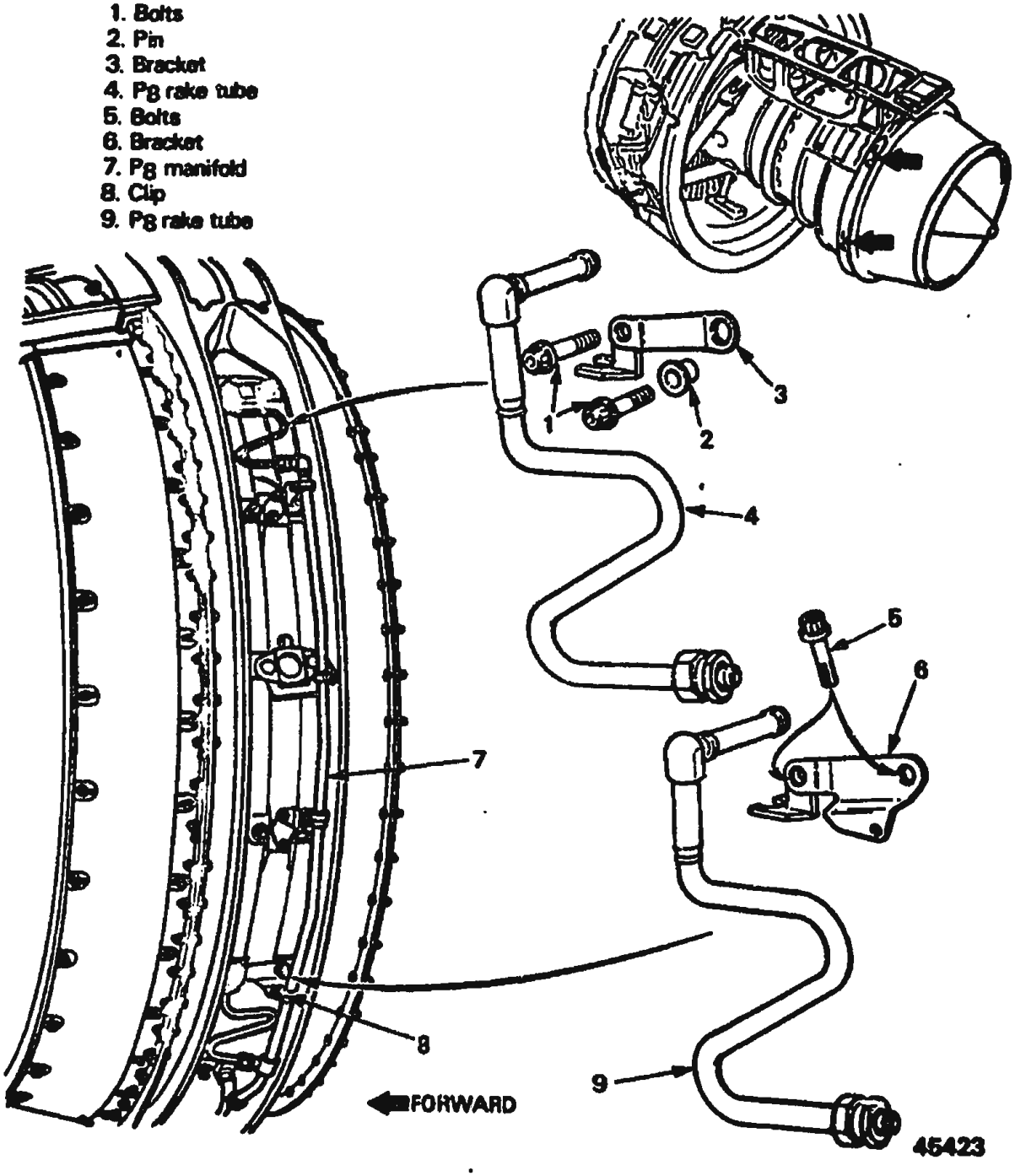
R EFFECTIVITY: ALL




1. Bolt
2. Tube
3. Bolt and Washer
4. Bolt
5. Bolt
6. Bracket
7. Tube

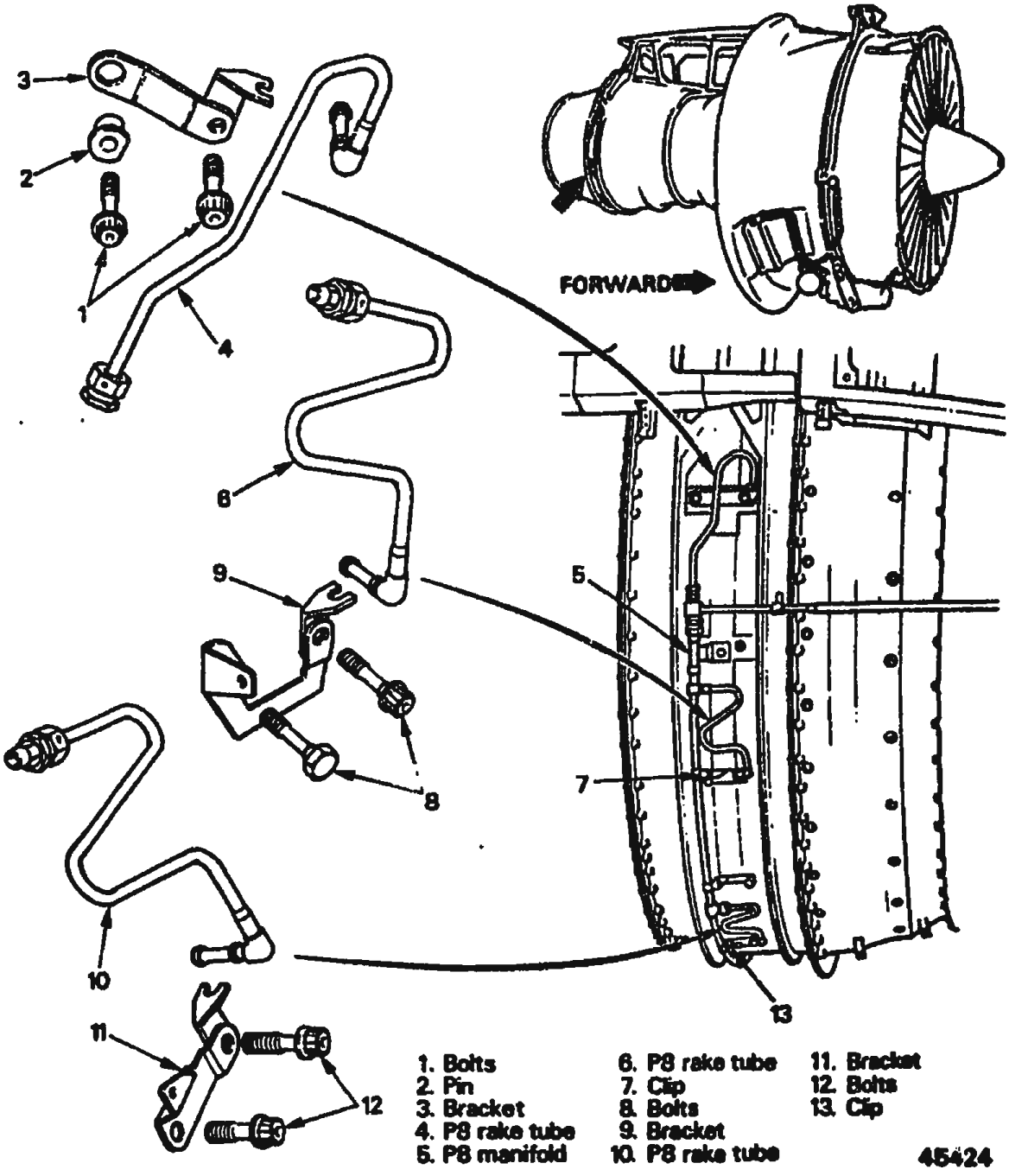
38264

R P8 rake tube - removal/installation
R (Engines without S.B.72-5221)
R Fig.401 (Sheet 2)




R P8 rake tube - removal/installation
R (Engines with S.B.72-5221)
R Fig.402 (Sheet 1)

R EFFECTIVITY: ALL




1. Bolts
2. Pin
3. Bracket
4. P8 rake tube
5. P8 manifold
6. P8 rake tube
7. Clip
8. Bolts
9. Bracket
10. P8 rake tube
11. Bracket
12. Bolts
13. Clip

45424

R P8 rake tube - removal/installation
R (Engines with S.B.72-5221)
R Fig.402 (Sheet 2)

R EFFECTIVITY: ALL

R (7) Install tube (2) then fit, but do not tighten bolt (1).

R (8) Connect and secure (Ref.70-51-00) tube (2) then
R wirelock.

R (9) Tighten bolt (1).

R (10) Refer to fig.401 (Sheet 1), move bracket (12) to give
R clearance, install tube (11) then fit but do not
R tighten bolt (9) ensuring bracket (12) is positioned
R correctly.

R (11) Connect and secure (Ref.70-51-00) tube (11) then
R wirelock.

R (12) Tighten bolts (9) and (10) then fit and secure bolt
R and washer (8).

R (13) Move bracket (7) to give clearance, install tube (6)
R then fit but do not tighten bolt (4) ensuring bracket
R (7) is positioned correctly.

R (14) Connect and secure (Ref.70-51-00) tube (6) then
R wirelock.

R (15) Tighten bolts (4) and (5) then fit and secure bolt
R and washer (3).

R (16) Install tube (2) then fit, but do not tighten bolt (1).

R (17) Connect and secure (Ref.70-51-00) tube (2) then
R wirelock.

R (18) Tighten bolt (1).

R (19) Fit gas generator fairings removed in operation A.(4).

R (20) Remove protective work mats.

R (21) Unlock and reactivate thrust reverser and associated
R systems (Ref.78-30-00).

R D. Install P8 rake tube (Engines with S.B.72-5221)

R (1) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Lockwire | DTD189A 22 S.W.G. | - 21 A.W.G. | 238 |

R (2) Ensure thrust reverser locks fitted, operation B.(2).

R (3) Ensure protective work mats positioned in cold stream duct.

R (4) Refer to fig.402 (Sheet 1), install tube (4), bracket (3) and pin (2) then loosely fit bolts (1).

R (5) Connect and secure (Ref.70-51-00) tube (4) to manifold (7) then wirelock.

R (6) Tighten bolts (1).

R (7) Install tube (9) and bracket (6) then loosely fit bolts (5).

R (8) Connect and secure (Ref. 70-51-00) tube (9) to manifold (7) then wirelock.

R (9) Tighten bolts (5).

R (10) Secure clip (8) to bracket (6).

R (11) Refer to fig.202 (Sheet 2), install tube (4), bracket (3) and pin (2) then loosely fit bolts (1).

R (12) Connect and secure (Ref. 70-51-00) tube (4) to manifold (5) then wirelock.

R (13) Tighten bolts (1).

R (14) Install tube (6) and bracket (9) then loosely fit bolts (8).

R (15) Connect and secure (Ref. 70-51-00) tube (6) to manifold (5) then wirelock.

R (16) Tighten bolts (8).

R (17) Secure clip (7) to bracket (9).

R (18) Install tube (10) and bracket (11) then loosely fit
R bolts (12).

R (19) Connect and secure (Ref. 70-51-00) tube (10) to manifold
R (5) then wirelock.

R (20) Tighten bolts (12).

R (21) Secure clip (13) to bracket (11).

R (22) Fit gas generator fairings removed in operation B.(4).

R (23) Remove protective work mats.

R (24) Unlock and reactivate thrust reverser and associated
R systems (Ref. 78-30-00).

R # L.P. TURBINE BEARING SUPPORT ASSEMBLY -
R # ADJUSTMENT/TEST

R Referenced Procedures:

R 70-51-00 Torque Tightening Technique
R 72-03-00 Gas Generator Fairings - Removal/Installation
R 72-51-03 L.P. Turbine Bearing Support Assembly - Approved Repairs
R 78-30-00 Thrust Reverser - Servicing

R 1. Pressure Check P8 Rake and Tube

R A. Equipment required:

| | |
|---|---|
| R CP.20309 or XUT.37594 | Working platform |
| R or (XUT.42526 | Spacer |
| R (XUT.42527 | Side piece |
| R Adaptor - thread size 0.8750 - 14UNJF - 3B | |
| R Clean, dry air supply capable of delivering 20 p.s.i.g. | |

R B. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| R Lockwire | DTD.189A 22 S.W.G. | - | 238 |
| R | | 21 A.W.G. | |
| R Masking Tape | - | - | - |

R C. WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
R Deactivate and tag thrust reverser and associated systems, and fit thrust reverser locks (Ref. 78-30-00).

R D. Fit working platform in cold stream duct.

R E. Establish L.P. turbine spoke fairings fitted with P8 rake (5 off) and using tape, mask off fairings ensuring the four holes in the leading edge of each fairing are completely blanked.

R F. Remove following access panels (Ref.72-03-00):

R (1) Engines No.1 and 3

R Combustion Section R.H. Fairing 412JR or 422JR
R Compressor Section Rear R.H. Fairing 412FR or
R 422FR
R Compressor Section Front R.H. Fairing 412BR or
R 422BR
R Compressor Section Upper R.H. Fairing 412AR or
R 422AR

R (2) Engine No.2

R Combustion Section R.H. Fairing 432JR
R Compressor Section Rear R.H. Fairing 432FR
R Compressor Section Front R.H. Fairing 432BR
R Compressor Section Upper R.H. Fairing 432AR

R G. Refer to fig.501, disconnect and remove P8 air tube at
R PF/P8 splitter and bulkhead connector.

R H. Fit adaptor to P8 air tube connector at bulkhead then
R using suitable equipment to supply clean, dry air, fit
R feed line to adaptor on P8 tube and pressurize P8
R manifold to 20 p.s.i.g.

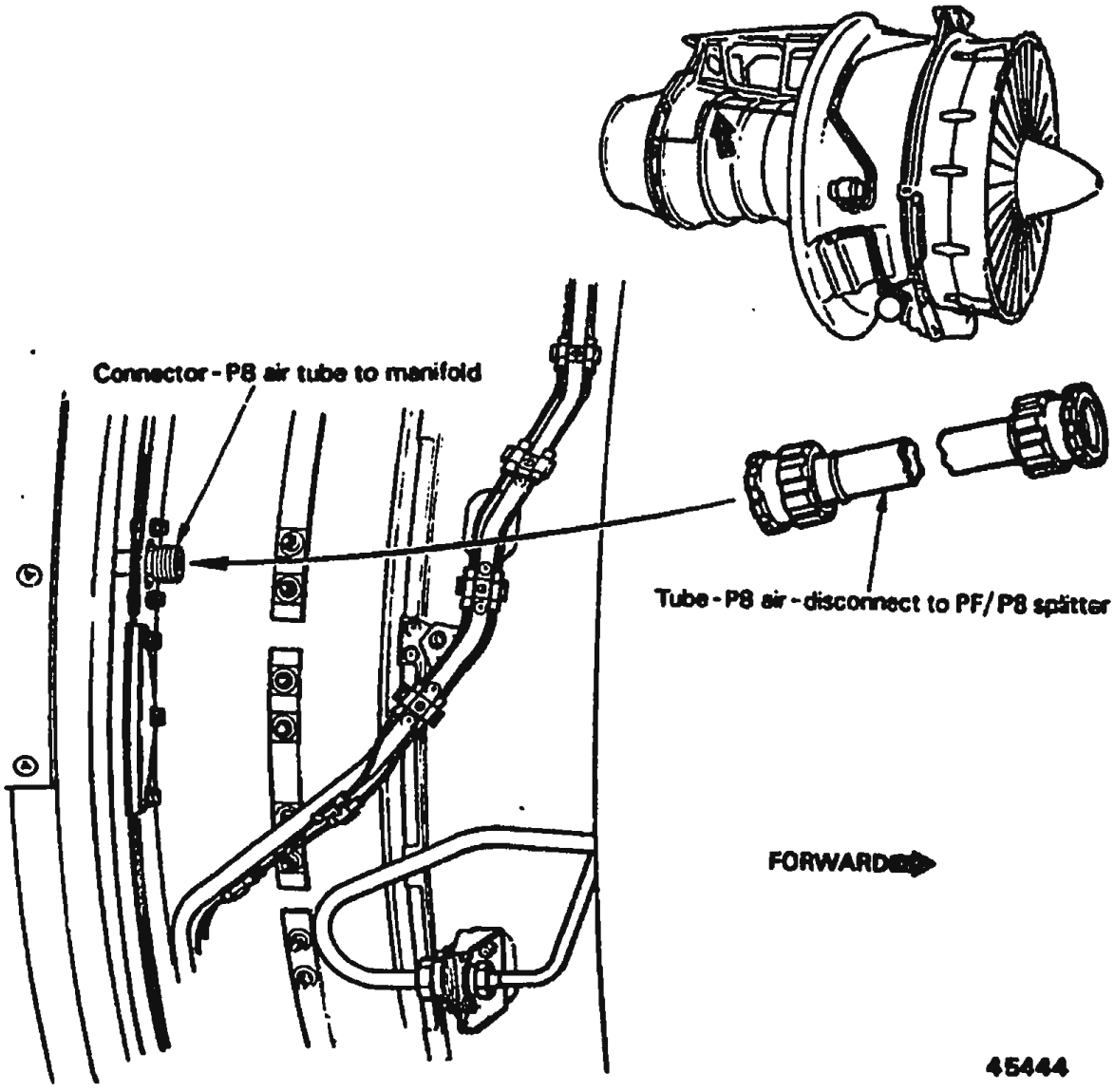
R J. Check at each of the five L.P. turbine spoke fairings
R for a large air leak. A small amount of air leakage
R is normal because the P8 rake tube is a slip fit
R into the P8 rake. A large air leak evidenced by a
R loud hissing noise at one or more spoke fairing
R indicates one or more P8 tubes and/or rakes are broken.
R One broken rake and/or tube is acceptable provided the rake
R tube is blanked (Ref.72-51-03, FRS.1066).

R K. Remove air supply and adaptor from P8 air tube
R connector.

R L. Fit and secure (Ref. 70-51-00) P8 air tube to PF/P8
R splitter and bulkhead connector then wirelock.

R M. Install access panels (Ref. 72-03-00) removed in
R operation (6).

R N. Remove tape from L.P. turbine spoke fairings, ensuring
R the four holes in the leading edge of each fairing
R are clear.




R P8 air tube disconnect and pressurization points
R Fig.501

R P. Remove working platform from cold stream duct.

R Q. Unlock and reactivate thrust reverser and associated
R systems (Ref. 78-30-00).

## L.P. TURBINE BEARING SUPPORT ASSEMBLY - INSPECTION/CHECK

Referenced Procedures:

72-51-03 L.P. Turbine Bearings Support Assembly - Removal/Installation and Approved Repairs

1. Inspect P8 Rake and Tube

   A. Remove P8 rake tube (Ref.72-51-03 Removal/Installation)

   B. Inspect P8 rake tube for cracks and separation.

      For acceptance standards see Para. 2.

   C. Install P8 rake tube (Ref.72-51-03 Removal/Installation)

2. Acceptance Standards

   A. Cracks or separation of nore than one tube are not acceptable.

   B. Where tube is separated and broken piece cannot be removed it is acceptable to blank only one tube on an engine (Ref.72-51-03, Approved Repairs FRS.1066).

R 3. Inspect Spoke Fairings

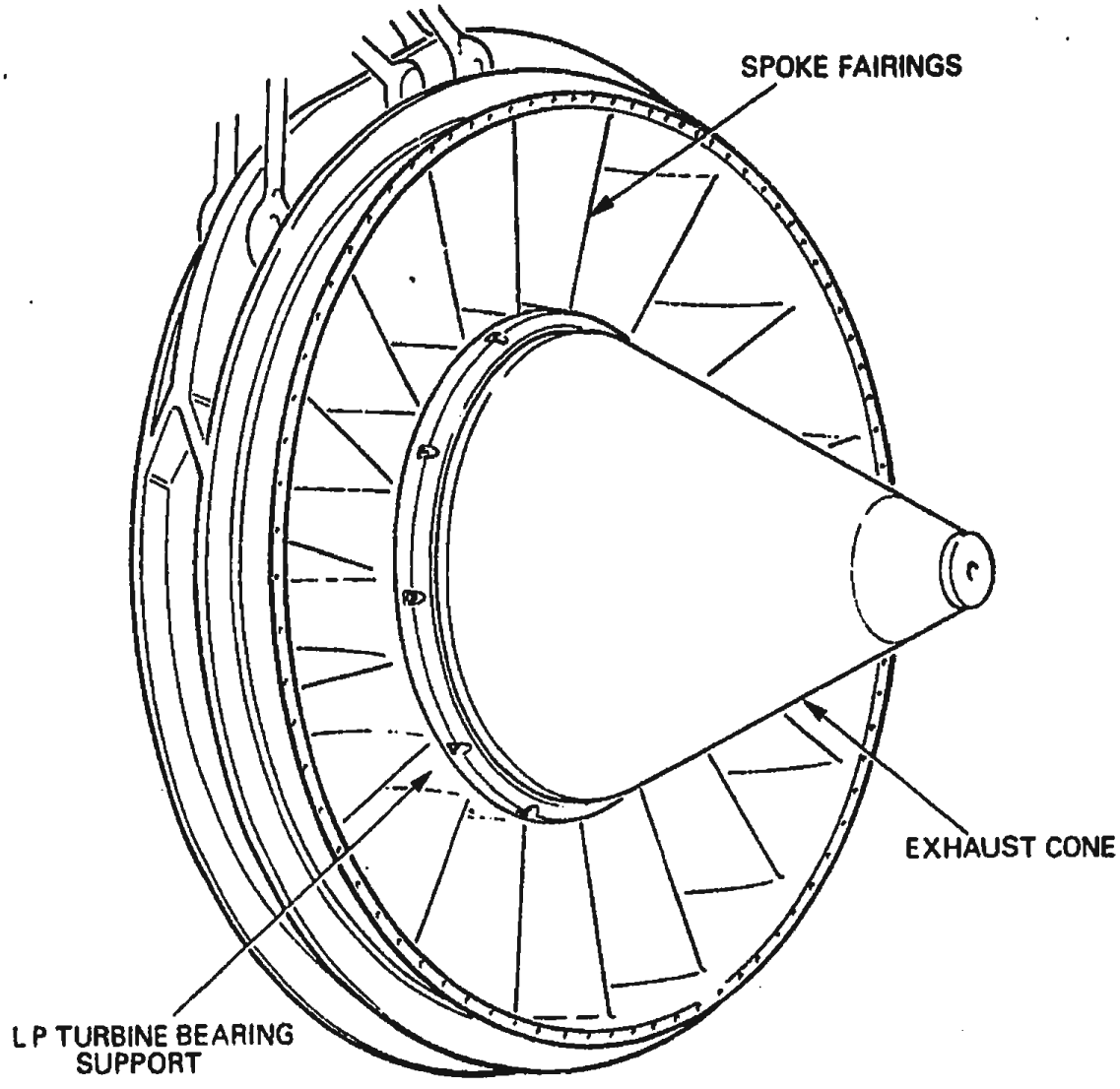
R A. Equipment required:

R 289200 or C4G4342 Protective work mats

R B. WARNING: ENSURE THRUST REVERSER IS LOCKED IN FORWARD
R THRUST POSITION WHILE WORK IS IN PROGRESS.

R Deactivate and tag thrust reverser and associated systems,
R fit thrust reverser locks (Ref. 78-30-00).

R C. Position protective work mats in cold stream duct.




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R L.P. Turbine Bearing Support Assembly - Inspection/Check
R Fig.601

R D. Refer to fig.601, gain access to exhaust unit and inspect
R spoke fairings for:

R (1) Cracks

R (2) Missing material

R For acceptance standards see para.4.

R E. Unlock and reactivate reverser and associated systems.

R 4. Acceptance Standards

R A. Cracking in any pattern is acceptable provided there are
R no indications that material will become detached.

R B. Material missing from aerofoil sections or causing loss of
R location - reject.

R L.P. TURBINE BEARING SUPPORT ASSEMBLY

R APPROVED REPAIRS

R LIST OF REPAIRS


| R Repair No. | Title | Page No. |
|---|---|---|
| R FRS.1066 | Blank P8 Rake and Tube by Welding | 803 |

R This page left blank intentionally

R BLANK P8 RAKE AND TUBE BY WELDING

R FRS.1066

R 1. Effectivity - All

R A. Component material:

| R Description | R.R. Symbol | Material |
|---|---|---|
| R P8 rake tube | EAF | 18/8 stainless |

R B. Welding data:

| | | |
|---|---|---|
| R Type of welding | - | Argonarc D.C. output |
| R Torch | - | B.O.C. W200 (or equivalent) |
| R Electrode | - | Thoriated tungsten |
| R Current | - | 25 amps |
| R Argon flow | - | 8 cubic feet/hour |

R C. Material required:

| R | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| R Filler rod | MSRR.950/2<br>B.S.2901:<br>1970 347 596 | - | 306 |
| R Heat resistant paint (Yellow) | PL.111 | - | 7/110 |
| R Degreasing fluid (Inhibited and stabilised 1.1.1. trichloroethane) | B.S.4487: 1969 | MIL-T-81533 | 1/21 |

R D. General

R (1) This repair instructs the procedure for blanking
R cracked or separated P8 rake and tube as initially
R issued by Non-Mod Service Bulletin 77-5726.

R (2) One P8 rake and tube only shall be blanked at any
R one time, and is to be indentified by marking the tube
R external surfaces with yellow heat resisting paint.

R (3) It is essential to remove the P8 rake tube from the
R engine before effecting this repair.

R E. Instructions

R (1) Remove P8 rake tube (Ref. 72-51-03,
R Removal/Installation).

R (2) WARNING: WHEN USING DEGREASING FLUID AVOID SKIN
R CONTACT AND INHALING THE VAPOUR.
R Cold liquid degrease P8 tube and prepare probe tube
R connector surface for welding.

R (3) Argon arc weld probe tube connector, ensure end of
R tube is completely sealed..

R (4) Dress weld flush with outside diameter of tube.

R (5) Perform dye penetrant crack test (T.S.D.594, O.P.210
R or 213)

R (6) Mark external surfaces of tube with yellow heat
R resistant paint.

R (7) Fit P8 rake tube (Ref. 72-51-03, Removal/Installation).

## INTERMEDIATE PRESSURE (I.P.) TURBINE - INSPECTION/CHECK

1. Inspect I.P. Turbine Blades

A. Inspection

(1) Using boroscope equipment and procedures, for turbine blades front surface (Ref. 72-00-00, Inspection/Check, para.6) and for turbine blades rear surface (Ref. 72-00-00, Inspection/Check, para.7) inspect for following.

(a) Inspect leading edge of blades for cracks and foreign object damage.

(b) Inspect trailing edge of blades for cracks and foreign object damage.

(c) Inspect airfoil surfaces for foreign object damage.

(d) Inspect and record gap size between all I.P. turbine blade lockplates.

NOTE: This is carried out when inspecting I.P. turbine blades rear surface.

For acceptance standards see 1.B.

B. Acceptance Standards

NOTE: To assist in assessing damage, the dimensions of I.P. turbine blades are given on fig.601.

R Cracks in blades are not acceptable. Damage within 0.200in.
R (5,08 mm.) of blade root or shroud platform is not acceptable.

Damage within the following limitations is acceptable.

(1) Leading edge

(a) Smooth bottomed dents, providing the individual length does not exceed 0.05in. (1,27 mm.) and there is a minimum of 0.10in. (2,54 mm.) between dents.

(b) A single smooth bottomed dent, providing the length does not exceed 0.125in. (3,175 mm.).

(c) No sharp or sudden change in leading edge contour.

(2) Trailing edge

(a) Two smooth bottomed dents, providing the individual length does not exceed 0.25in. (6,35 mm.) and there is a minimum of 1.50in. (38,10 mm.) between dents.

(b) No sharp or sudden change in trailing edge contour.

(3) Airfoil surfaces

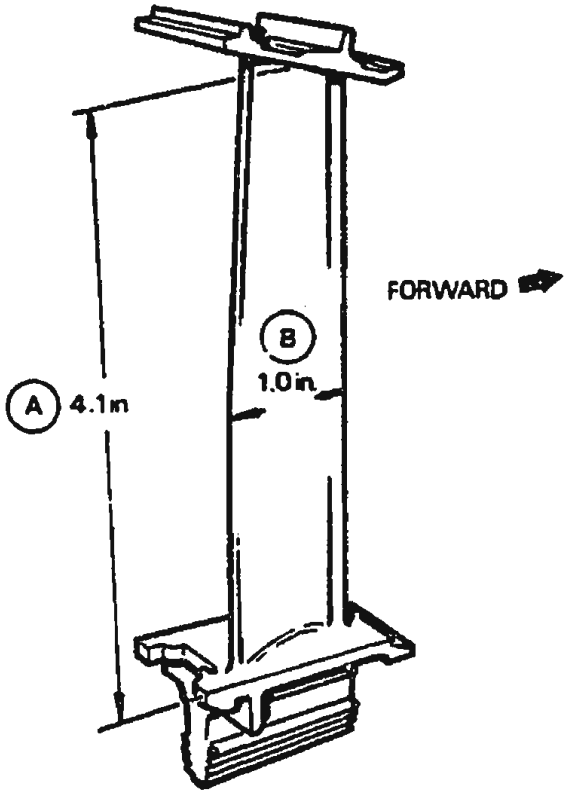
(a) Smooth bottomed dents providing the individual diameter does not exceed 0.10in. (2,54 mm.).

(b) Nicks and scratches providing the width does not exceed 0.02in. (0,51 mm.) and the length does not exceed 0.05in. (1,27 mm.).

(c) Foreign object spatter.

R (4) I.P. turbine blade lockplates

R (a) A total cumulative gap between all lockplates
R not exceeding 0.425in. (10,8 mm.) or a total
R cumulative gap between any three adjacent
R lockplates not exceeding 0.275in. (6,99 mm.)
R is acceptable.




(A) Approximate height measured at centre-line of blade

(B) Approximate width measured at mid-height of blade

NOTE: These are straight line approximate measurements and not the curved surface dimensions

39841

I.P. turbine blade, inspection/check
Fig.601

R INTERMEDIATE PRESSURE (I.P.) TURBINE CASE AND VANES COOLING
R DUCT FAIRINGS - INSPECTION/CHECK

R 1. General

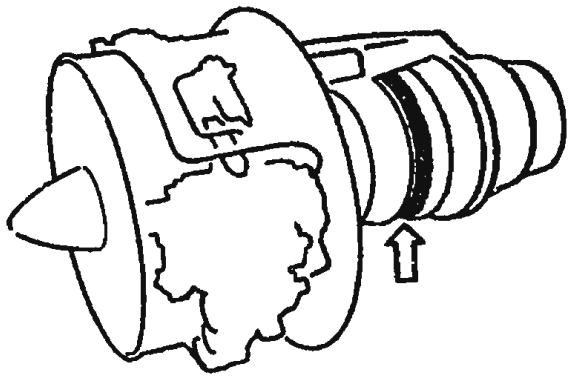
R NOTE: The acceptance standards contained in this chapter are
R non-routine and are to be carried out when an opportunity
R arises.

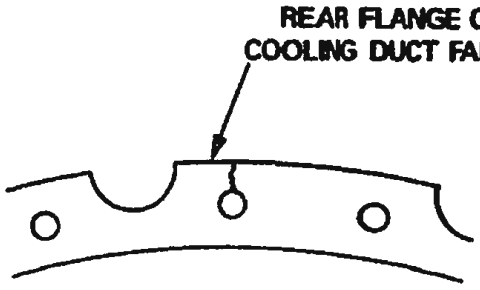
R 2. Inspect Intermediate Pressure (I.P.) Turbine Case Cooling Duct
R Fairing

R A. Visually inspect fairings at I.P./L.P. turbine flange for
R cracking (refer to Fig.601).

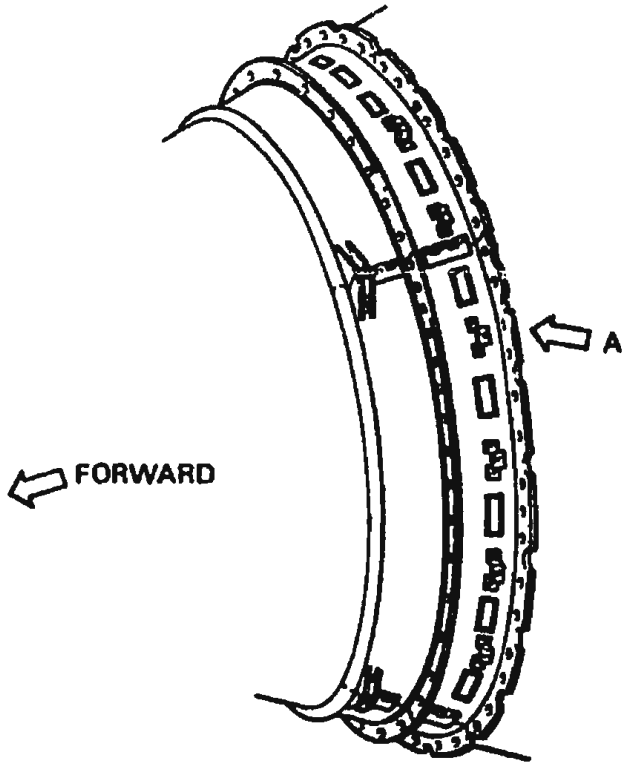
R 3. Acceptance Standards for Cooling Duct Fairings

R A. Any number of cracks extending radially outwards from the
R flange bolt holes to the rim are acceptable.






VIEW AT A
(Showing typical crack)




A9888

R I.P. turbine case cooling duct fairing - Inspection/Check
R Fig.601

## HIGH PRESSURE (H.P.) TURBINE - INSPECTION/CHECK

1. Inspect H.P. Turbine Nozzle Guide Vanes

A. Inspection

(1) Using borescope equipment and procedure (Ref. 72-00-00, Inspection/Check, para.5), remove combustion section borescope blanking plugs rear of fuel spray nozzle positions 2, 4, 6, 8, 10, 12, 14 and 16 and inspect nozzle guide vanes for the following damage:

(a) Concave, and as far as possible, the convex airfoil surfaces of each vane for cracks and foreign object damage.

(b) Each vane leading edge for burning and erosion.

(c) Each vane trailing edge for burning, nicks and tears.

(d) Blockage

(e) Each vane inner platform for burning and/or erosion.

For acceptance standards see para.B.

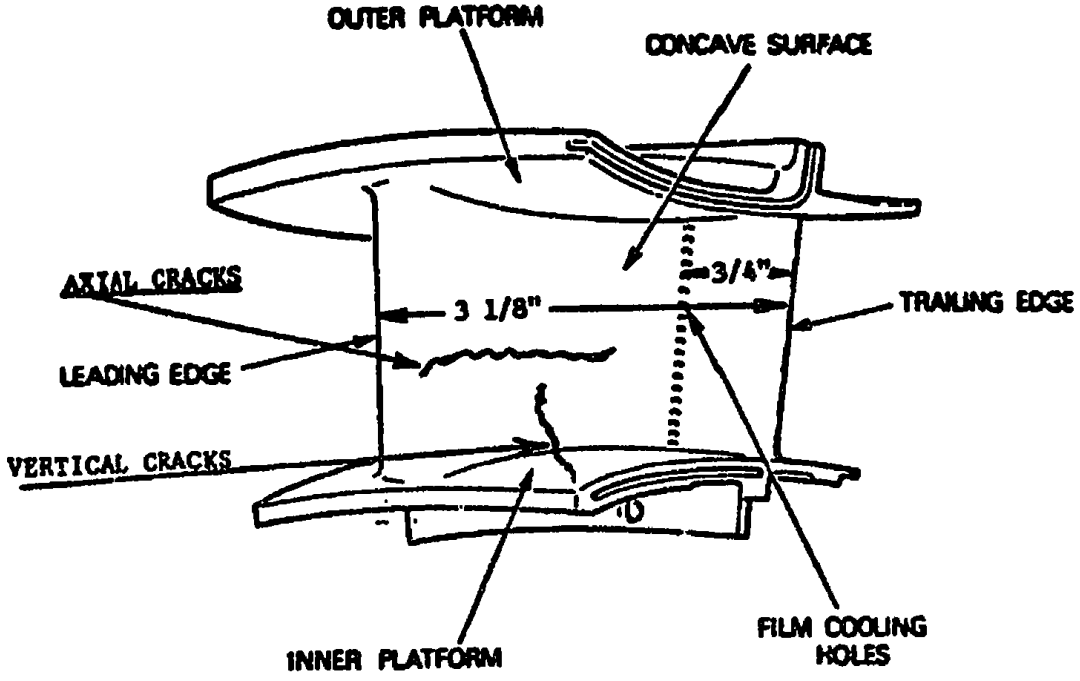
C B. Acceptance standards (Ref. fig.601)

(1) Cracks

(a) Airfoil surface of vane.

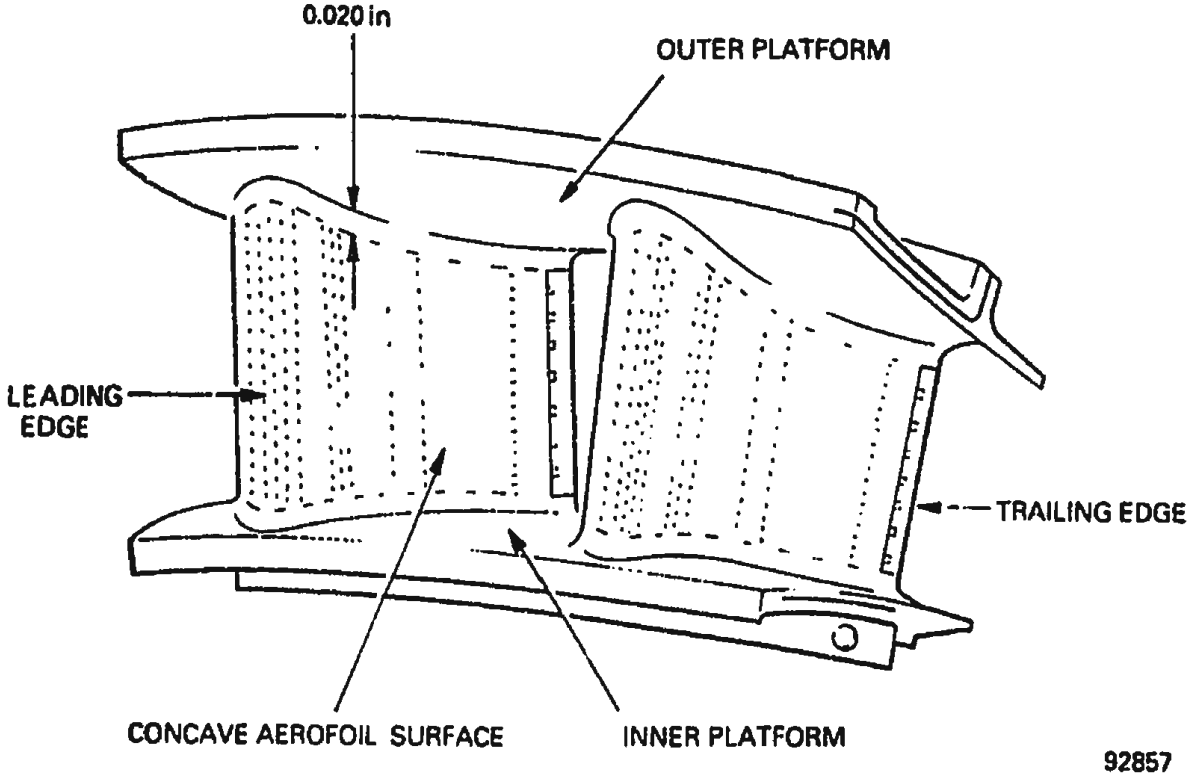
C (i) Axial cracks in the concave surface providing they do not exceed 2.125in. (53,975 mm.) in length and there is no lifting of material from original contours.

. C C C (ii) Vertical cracks in the concave or convex surface linking air holes, providing there is no lifting of material from original contours.



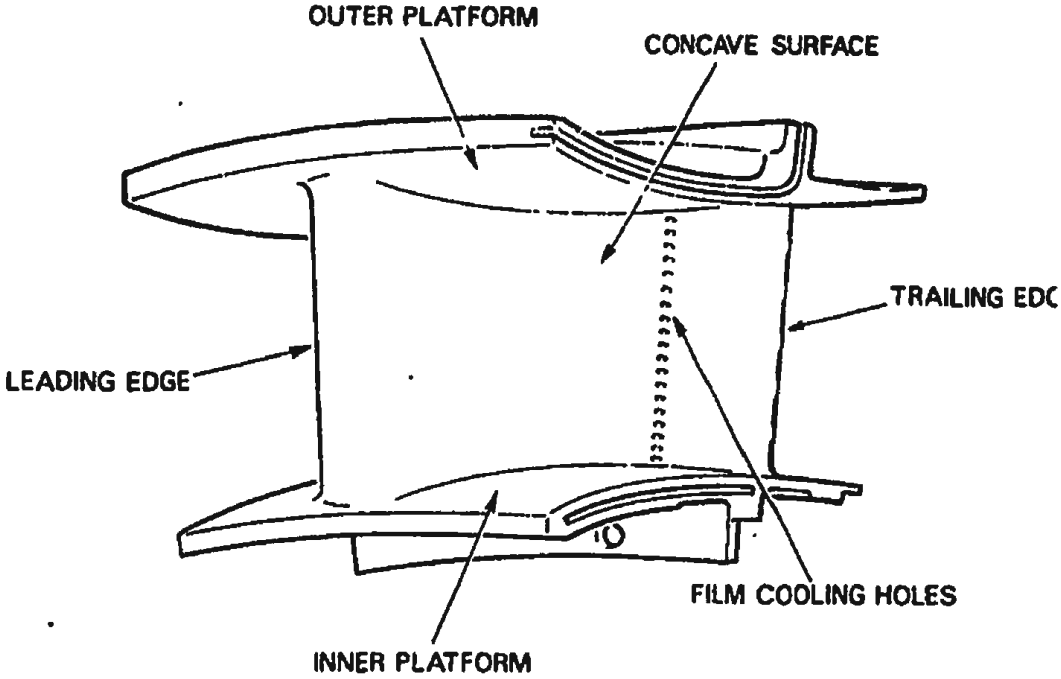

36368

C H.P. nozzle guide vane inspection/check
C Fig.601 (Sheet 1)




R H.P. nozzle guide vane inspection/check
R Fig.601 (Sheet 2)

LOWING ILLUSTRATION HAS BEEN ENTERED WITH NUMBER 26128D (PAGE




NOTE The approximate height of the vane (measured in a straight line at the vertical centre line) is 2.1 in

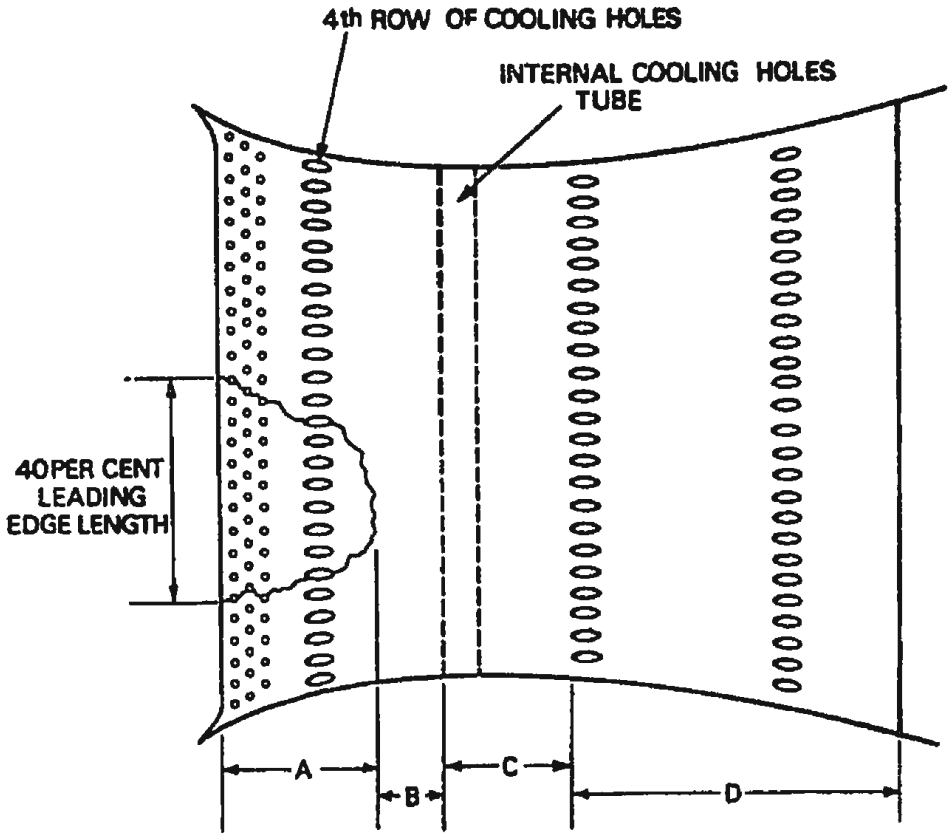
The approximate width of the vane (measured in a straight line at mid height position) from leading edge to trailing edge across the concave surface is 3.25 in

The approximate distance from edge of trailing edge cooling slot to the first row of film cooling holes across the concave surface is:
0.75in Pre SB 72-6147
0.30in SB 72-6147

2612

R H.P. nozzle guide vane inspection/check
R Fig.601 (Sheet 3)

HP NOZZLE GUIDE VANE PRESSURE SURFACE




32905A

H.P. nozzle guide vane - burning limits
Fig.602

(iii) Cracks in leading edge providing they are non-convergent, do not extend into convex surface film cooling holes or rearward to within less than 0.5in. (12,7 mm.) of any other crack and there is no lifting of material from original contours.

(iv) Multiple cracking in excess of (i), (ii), and (iii) above, provided that there is no evidence of material lifting or imminent material loss - Accept subject to re-inspection within 300 hours.

R (v) Mutiple cracking in excess of (i), (ii) and
R (ii) above with material lifting, provided
R there is no evidence of imminent material loss
R - Accept subject to re-inspection within 100
R hours.

R (vi) In excess of (v) - Reject engine eithin 50
R hours.

(vii) Cracks from vane trailing edge up to 0.50in. (12,7 mm.) in length - accept.

(viii) Cracks in excess of (vii) up to 1.00in. (25,4 mm.) in length, provided there is a minimum of 0.50in. (12,7 mm.) of crack free material between adjacent cracks - re-inspect within 250 hours.

(iv) Cracks in excess of (viii) - reject engine within 50 hours.

(b) Rate of crack propagation shows no sudden increase.

(c) Inner and outer platform cracking is acceptable provided the cracks are non-convergent and do not extend into the airfoil surface by more than 0.20in. (5,08 mm.)

(2) Burning and/or erosion

(a) Burning and/or erosion not penetrating vane leading edge.

C (b) Burning and/or erosion which penetrates vane
C leading edge in area A (Ref. Fig.602) not exceeding
C 0.19 inch diameter - inspect within 200 hrs.

C (c) Burning and/or erosion which penetrates vane
C leading edge in area A (Ref. Fig.602) not exceeding
C 0.40 inch diameter - inspect within 100 hrs.

(d) Burning and/or erosion which penetrates vane leading edge, and extends into area A (Ref. fig.602), providing it does not penetrate cooling tube, does not exceed 0.25in. (6,35 mm.) beyond 4th row of cooling holes on concave surface, and 40% of leading edge length - Re-inspect within 300 hours.

(e) Burning and/or erosion which penetrates vane leading edge greater than limits in para. (d) and extends into area B. (Ref.fig.602) is acceptable, providing it is less than mid-way between 4th and 5th row of cooling holes on concave surface, does not exceed 40% of leading edge length, and which causes a hole in cooling tube providing it does not exceed 0.20in. (5,08 mm.) in diameter - Re-inspect within 100 hours.

(f) Burning and/or erosion in excess of (a), (d) and (e) - Schedule engine removal within 10 hours.

(g) Burning at any position on trailing edge, not exceeding 0.5in. (12,7 mm.) of airfoil height and extending forward to but not beyond the rearmost row of cooling air holes.

(h) Burning and/or erosion of the inner platform leading to holing not exceeding 0.25in. (6,35 mm.) in diameter - Re-inspect within 300 hours.

(3) Foreign object damage

(a) Dents on airfoil surface providing vane section has not been punctured.

(b) Nicks or tears from vane trailing edge up to 0.50in. (12,7 mm.) in length - accept.

(c) Nicks or tears in excess of (b) up to 1.00in. (25,4 mm.) in length provided there is a minimum of 0.50in. (25,4 mm.) crack free material between adjacent nicks or tears - re-inspect within 250 hours.

(d) Nicks or tears in excess of (c) - reject engine within 50 hours.

(e) If foreign object damage is observed on H.P. nozzle guide vanes, the turbine blades, particularly the H.P. stage must be inspected for damage.

2. Inspect H.P. Turbine Blades

A. Inspection

(1) Using borescope equipment and procedure (Ref.72-00-00, Inspection/Check, para. 6, H.P. turbine blade procedure only) inspect blades for the following damage:

C (a) Trailing edge of each blade for cracks

(b) Leading edge, the concave and as far as possible the convex airfoil surfaces of each blade for foreign object damage.

(c) Blade shrouds, shroud interlocks and tip seal fins for cracks.

For acceptance standards see para. 2.B.

B. Acceptance standards (Ref.fig.603)

C (1) Cracks

(a) Radial cracks - leading edge, concave and convex airfoil surfaces

(i) A single or several radial cracks not exceeding a total length of 1.0in. (25,4 mm.) or linking more than 14 cooling air holes - Accept.

(ii) A single or several radial cracks in excess of (i) but not exceeding 1.20in. (30,48 mm.) in length with no evidence of opening or burning - Re-inspect every 250 hours or 100 flights whichever is the sooner.

(iii) Radial cracks in excess or (i) and (ii) - Remove engine within 10 flights or 25 hours whichever is the sooner.

(b) Radial cracks - trailing edge

(i) A single or several cracks not exceeding a total length of 0.30in. (7,62 mm.) - Accept.

(ii) Radial cracks in excess of (i) - Remove engine within 10 flights or 25 hours whichever is the sooner.

(c) Axial cracks

(i) Axial cracking on the concave aerofoil of the blade not extending to the trailing edge and not exceeding 0.15ins (3.81 mm.) in length - Re-inspect every 50 flights or 125 hours whichever is the sooner.

(ii) Axial cracking on the concave aerofoil of the blade, outside the limits in (i), not extending to the trailing edge and not exceeding 0.30in. (7,62 mm.) in length - Remove engine within 25 flights or 65 hours whichever is the sooner.

(iii) Axial cracking extending to the trailing edge engines without S.B.72-5089 - Reject - Schedule C engine change within 25 flight hours C

C (iv) Axial cracking on the convex airfoil surface
C or leading edge - Reject - Schedule engine change within 25 flight hours.

(d) Axial cracks - trailing edge. Engines with S.B.72-5089

(i) Axial cracking propagating from the trailing edge, not exceeding 0.050in. (1,27 mm.) in length and within 0.200in. (5,08 mm.) of the inner platform - Accept.

(ii) Axial cracking in excess of (i) but not exceeding 0.100in. (2,54 mm.) - re-inspect within 200 flights or 500 hours whichever is the sooner.

(iii) Axial cracking in excess of (ii) - Reject.

(e) Cracks in blade shrouds, shroud interlocks and tip seal fins are acceptable.

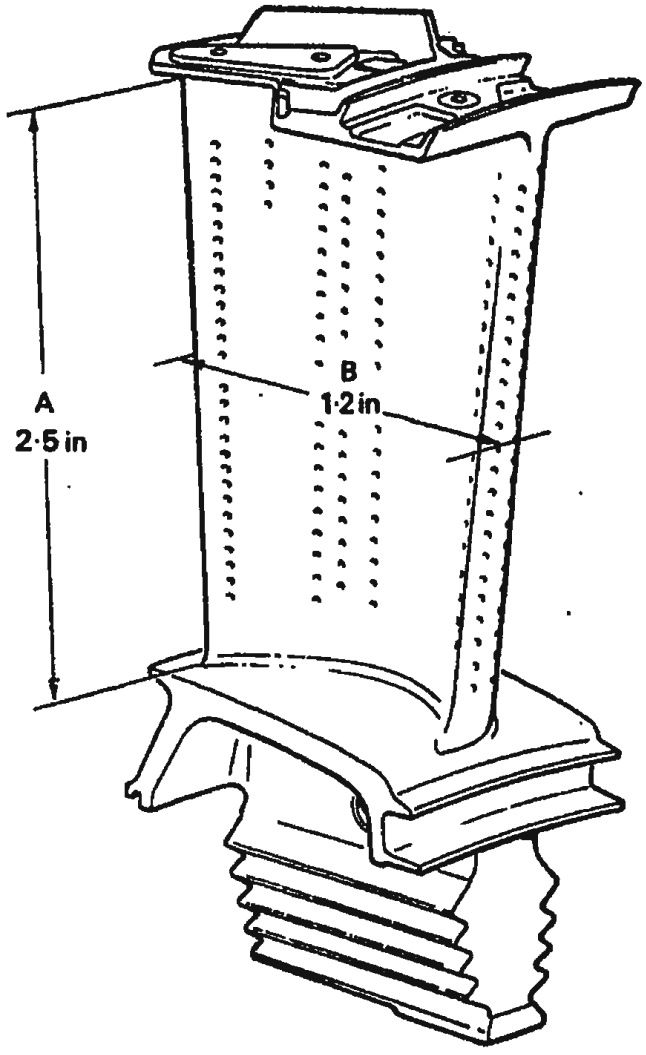
C (2) Foreign object damage. Engines with S.B.72-5089

(a) Leading edge

(i) Damage to the outer half of the leading edge, up to 0.30in. (7,62 mm.) radial by 0.20in. (5,08 mm.) circumferential with holing up to half the depth of the leading edge cooling air passage and no axial cracking associated with the damage - Accept.

(ii) Damage to the outer half of the leading edge in excess of (i) or with holing up to full depth of the leading edge cooling air passage, with cracking confined within the damage and not extending away from it. Re-inspect every 100 flights or 250 hours whichever is the sooner.

(iii) Damage to the outer half of the leading edge as described in (i) or (ii) from which axial cracking emanates not exceeding 0.050in. in length. Re-inspect every 50 flights or 125 hours whichever is the sooner.



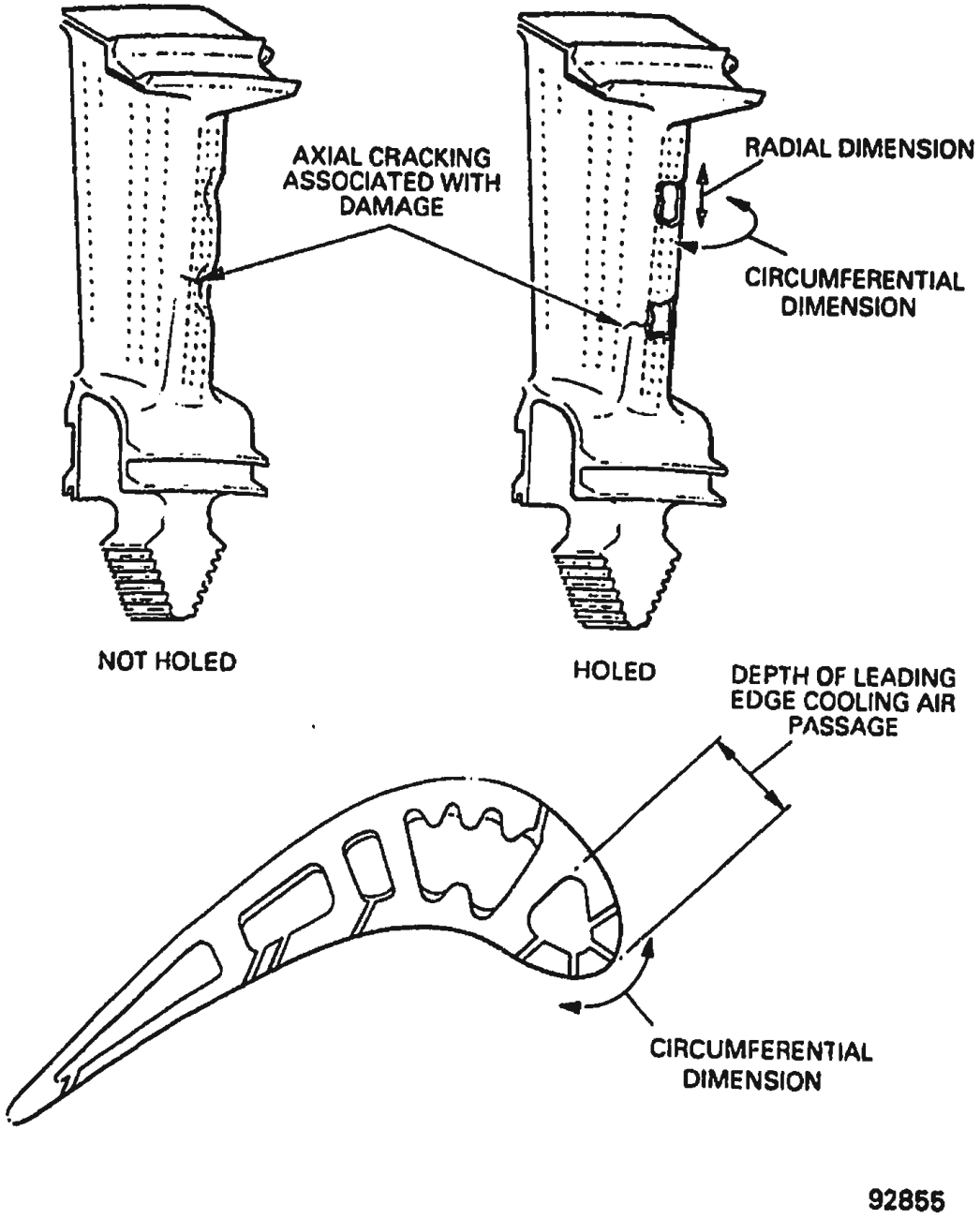

A Height of blade measured at centre line of blade

B Width of blade measured at mid height of blade

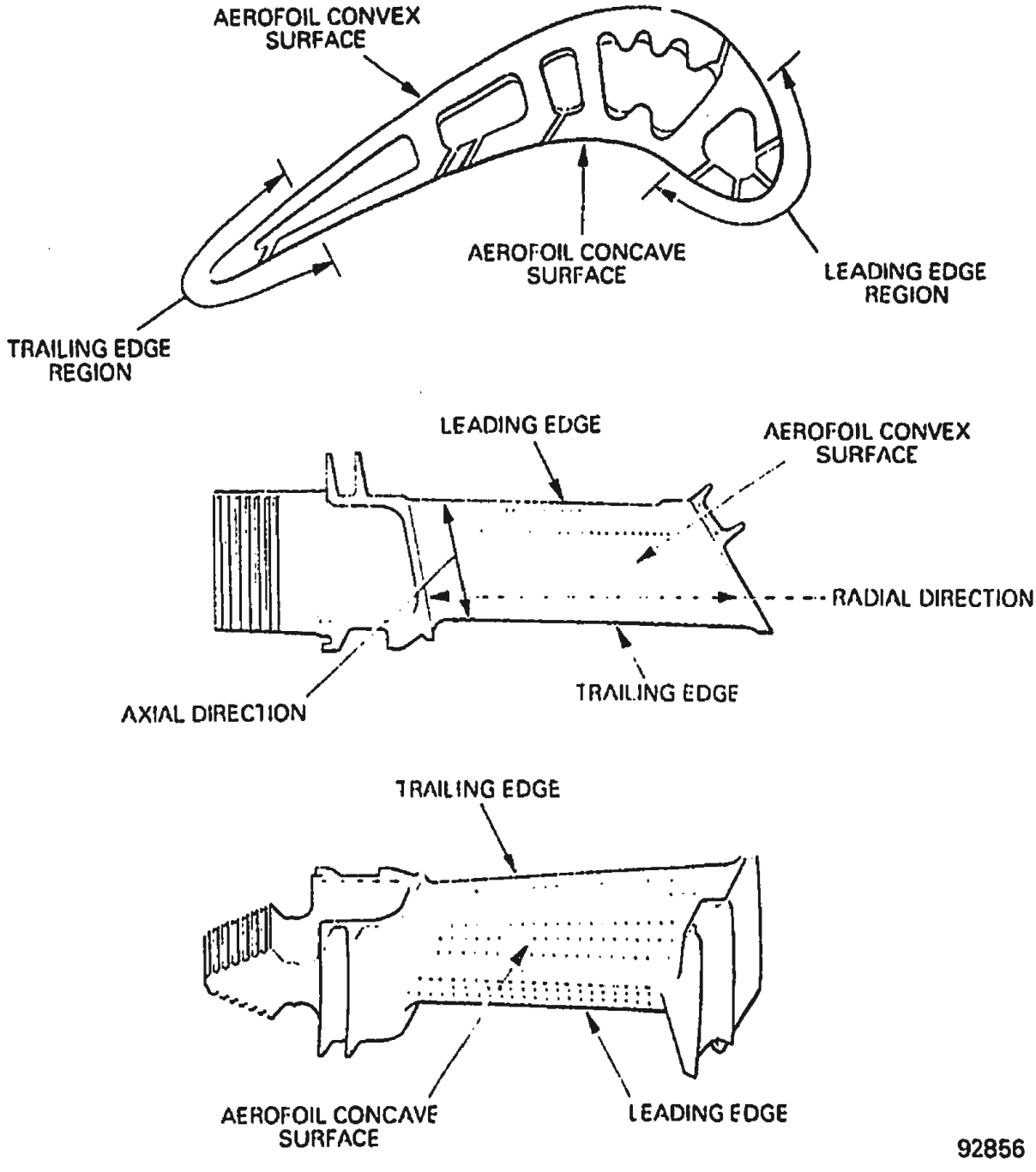
NOTE: These are straight line approximate measurements and not curved surface dimensions

58403

H.P. turbine blade - Inspection/Check
Fig.603 (Sheet 1)




H.P. turbine blade - Inspection/Check Area definitions
Fig.603 (Sheet 2)




H.P. turbine blade - Inspection/Check Foreign Object Damage
Fig.603 (Sheet 3)

(iv) Damage to the inner half of the leading edge up to 0.300in. (7,62 mm.) radial by 0.15in. (3,81 mm.) circumferential with cracking confined within the damage and not extending away from it. Re-inspect every 50 flights or 125 hours whichever is the sooner.

(v) Damage in excess of (ii), (iii) or (iv) but confined to the leading edge region - remove engine within 10 flights or 25 hours whichever is the sooner.

(vi) Damage in excess of (v) extending outside of leading edge region or if there is a danger of imminent material loss - reject engine.

(b) Trailing edge

(i) Damage up to 0.15in. (3,81 mm.) in diameter with no associated holing or cracking - Re-inspect within 50 flights or 125 hours whichever is the sooner.

(ii) Damage within the limits of (i) but with associated cracking or holing, or in excess of the limits in (i) - Remove engine within 5 flights or 10 hours whichever is the sooner.

(c) Concave and Convex airfoil surfaces

(i) Damage up to a depth of 0.05in. (1,27 mm.), round bottomed and not within 0.25in. (6,35 mm.) from the leading or trailing edges - Accept.

(ii) Damage to the limits in (i) but having sharp edges - Re-inspect every 100 flights or 250 hours whichever is the sooner.

(iii) Damage within the limitations of (i) and (ii) but with associated cracking - The acceptance limits detailed in para.2.B.(1) will apply.

(iv) Damage in excess of (i), (ii) and (iii) - Remove engine within 25 flights or 65 hours whichever is the sooner.

(3) Erosion

(a) Leading edge of blade

(i) Erosion of the leading edge over its full length with no collapse and/or holing - Accept.

(ii) Erosion with associated leading edge collapse and/or holing, but with no associated axial cracking - Re-inspect every 100 flights or 250 hours whichever is the sooner.

(iii) Erosion in excess of (i) and (ii) - Remove engine within 10 flights or 25 hours whichever is the sooner.

(iv) Rubbing adjacent to the shroud with no collapse and/or holing - Accept

(v) Rubbing adjacent to the shroud with associated leading edge collapse and/or holing, but with no associated axial cracking - Re-inspect every 100 flights or 250 hours whichever is sooner.

(vi) Rubbing, adjacent to the shroud in excess of (iv) and (v) - Remove engine within 10 flights or 25 hours whichever is the sooner.

(4) Burning (Engines with 72-5089)

(a) Concave and Convex airfoil surfaces.

(i) Burning or discolouration without holing is acceptable. Re-inspect within 150 hours or 100 cycles whichever is the sooner.

(ii) Burning in excess of (i) with holing - Reject within 10 hours or 5 flights which ever is the sooner.

(5) Sulphedation

(a) Sulphedation on all airfoil surfaces and platform/ shroud gas washed surfaces - Accept.

## EXHAUST UNIT AND CONE - REMOVAL/INSTALLATION

1. Removal/Installation Exhaust Cone

R CAUTION: 1. THE EXHAUST CONE WEIGHS APPROXIMATELY 19 LBS
R (8.6 KG).

2. ENSURE THRUST REVERSER IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.

A. Remove Exhaust Cone

(1) Deactivate and tag thrust reverser and associated systems, and fit thrust reverser locks (Ref. 78-30-00, Servicing).

(2) Refer to fig.401, support exhaust cone and remove
R securing bolts (9 off.) Engines with S.B.72-4822,
R access to bolts is through slots in outer skin.

R NOTE: 1. Engines without S.B.72-4822, the
R exhaust cone is dowelled at each securing
R bolt location.

R 2. Engines with S.B.72-4822, the exhaust
R cone is dowelled at three equally spaced
R positions.

R (3) Engines without S.B.72-4822:

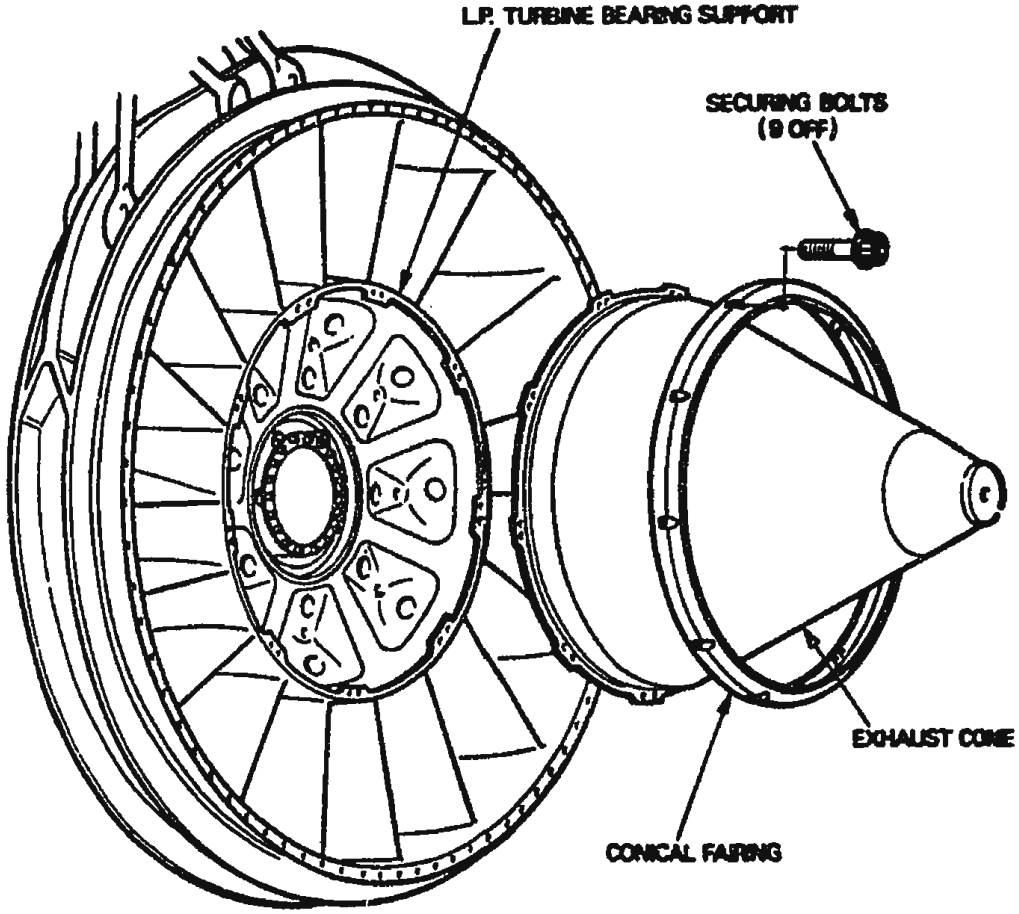
Withdraw conical fairing then remove exhaust cone from L.P. bearing support.

R (4) Engines with S.B.72-4822:

R Remove exhaust cone from L.P. bearing support.

B. Install Exhaust Cone

(1) Ensure thrust reverser is locked and systems are deactivated and tagged as detailed in operation A.(1).




R Exhaust cone removal/installation
R Fig.401

(2) Engines without S.B.72-4822:

Locate exhaust cone dowels in L.P. turbine bearing support, fit conical fairing and securing bolts (9 off).

NOTE: The exhaust cone is acceptable with dowel pins missing, provided at least three, equally spaced around the flange circumference remain intact.

R (3) Engines with S.B.72-4822:

R Locate exhaust cone dowels in L.P. turbine bearing
R support, and fit securing bolts (9 off) through
R slots in cone skin.

R NOTE: The exhaust cone is not acceptable with
R dowel pins missing.

(4) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00 Servicing).

# EXHAUST UNIT AND CONE - INSPECTION/CHECK

Referenced Procedures

| | |
|---|---|
| 72-03-00 | Gas Generator Fairings - Removal/Installation |
| 78-30-00 | Thrust Reverser - Servicing |
| 70-42-11 | Standard Practices |

Service Bulletins referred to:

| | |
|---|---|
| 72-4485 | Exhaust Unit and Cone - Transition Case in Heat Resisting Material with Axial Slots and Close-out Sections |
| 72-4822 | Exhaust Unit and Cone - Exhaust Cone in Heat Resisting Material with Axial Slots in the Accoustic Lining |

1. Inspect Exhaust Cone

A. Inspection

(1) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref. 78-30-00).

(2) On engines without S.B.72-4822, gain access to exhaust unit and inspect exhaust cone for following damage:

(a) Cracks

(b) Lifting and peeling of perforate

For acceptance standards see 1.B.

(3) On engines with S.B.72-4822, gain access to exhaust unit and inspect exhaust cone for following damage:

(a) Refer to fig.601, Inspect outer skin for dents, nicks and scores and cracks. For acceptance standards see para.1.C.

(b) Inspect front make-up piece for dents, nicks and scores and cracks. For acceptance standards see para.1.C.

(c) Inspect conical end piece for dents, nicks and scores and cracks. For acceptance standards see para.1.C.

(d) Inspect inner skin for cracks. For acceptance standards see para.1.C.

(e) Inspect front and rear angles for cracks. For acceptance standards see para.1.C.

(f) Inspect bolt tray for cracks. For acceptance standards see para.1.C.

(g) Inspect front flange abutment face for galling and distortion. For acceptance standards see para.1.C.

(4) Unlock and reactivate thrust reverser and associated systems (Ref. 78-30-00).

B. Acceptance Standards - Engines without S.B.72-4822

(1) Cracks

R (a) A single crack in the conical end piece up to 1.0in.
R (25,4 mm.) in length is acceptable for a maximum fly
R on period of 150 hours or 30 flights, whichever is
R the sooner. The exhaust cone must be replaced
R before or at the 150 hour/30 flight limit.

(b) Cracks outside the area of perforate skin are not acceptable.

(c) Circumferential or convergent cracks are acceptable provided there are no indications of eventual loss of metal which would exceed an area of 2.0 sq.in. (1290,0 sq.mm.).

(d) For repair of cracks outside acceptance standards refer to Approved Repairs (FRS.3652).

(e) Fly-on limits - perforate skin cracks

These limits may be applied for a maximum of 150 hours or 30 flights which ever is the sooner

(i) One single crack up to 4.0in. (101,6 mm.) in length is acceptable.

(ii) Circumferential or convergent cracks are acceptable provided they are contained in an area of 4.0in. (101,6 mm.) diameter and there is 5.0 in. (127 mm.) of sound material seperating the cracked areas.

(2) Loss of perforate metal

The exhaust cone is acceptable with up to two pieces of perforate skin missing provided neither exceeds 2.0 sq.in. (1290,0 sq.mm.) in area and are separated by a minimum of 6.0in. (152,4 mm.) of sound metal.

C (3) Cracks in the end cup of the exhaust cone to be
C removed by dressing out cracked/damaged area. The
C limit of area dressed out are in Figure 604.

C. Acceptance Standards - Engines with S.B.72-4822

(1) Outer skin

Damage within the following limitations is acceptable:

(a) Smooth, crack free dents up to 0.125in. (3,175 mm.) deep and not exceeding 4.00ins. (101,60 mm.) in diameter.

(b) Nicks and scores up to a depth of 0.002in. (0,50 mm.) provided they are crack free.

(c) A maximum of two circumferential cracks not exceeding 3.00ins. (76,20 mm.) in length with a minimum of 6.00ins. (152,40 mm.) of sound material between cracks.

(d) Axial cracks not exceeding 5.00ins. (127,00 mm.) in length with a minimum of 2.00ins. (50,80 mm.) of sound material between cracks.

(2) Front make-up piece

Cracks in front make-up piece are not acceptable.

Damage within the following limitations is acceptable:

(a) Smooth, crack free dents up to 0.100in. (2,54 mm.) deep and not exceeding 1.00in. (25,4 mm.) in diameter.

(b) Nicks and scores up to a depth of 0.003in. (0,76 mm.) provided they are crack free.

(3) Conical end piece

R (a) A single crack in the conical end piece up to 1.0in.
R (25,4 mm.) in length is acceptable for a maximum fly
R on period of 150 hours or 30 flights, whichever is
R the sooner. The exhaust cone must be replaced
R before or at the 150 hour/30 flight limit.

(b) Damage within the following limitations is acceptable:

(i) Smooth, cracks free dents up to 0.125in. (3,175 mm.) deep and not exceeding 2.00ins. (50,80 mm.) in diameter.

(ii) Nicks and scores up to a depth of 0.002in. (0.50 mm.) provided they are crack free.

(4) Inner skin

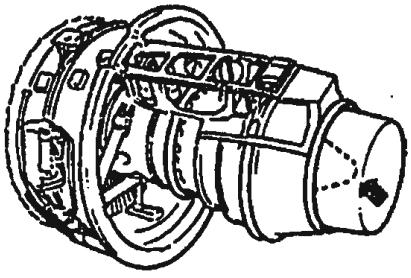
Damage within the following limitations is acceptable:

(a) A maximum of two circumferential cracks not exceeding 3.00ins. (76,20 mm.) in length with a minimum of 6.00ins. (152,40 mm.) of sound material between cracks.

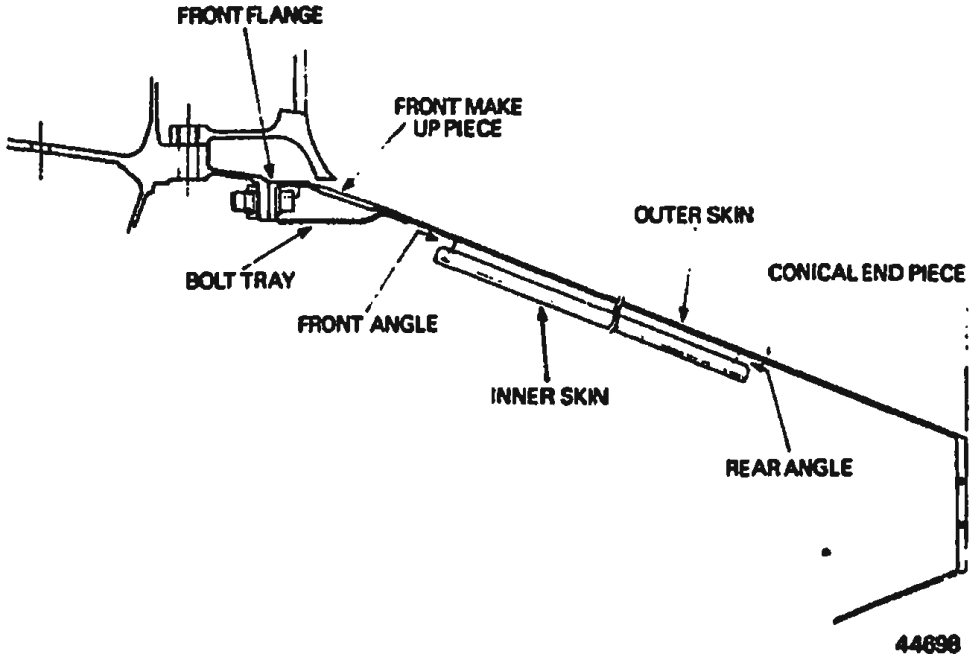
(b) Axial cracks not exceeding 5.00ins. (127,00 mm.) in length with a minimum of 2.00ins. (50,80 mm.) of sound material between cracks.

(5) Front and rear angles

Cracks in front and rear angles are not acceptable.



SECTION THROUGH EXHAUST CONE




R Exhaust cone - Inspection/Check
R (Engines with S.B.72-4822)
R Fig.601

(6) Bolt tray

Cracks in bolt tray are not acceptable.

(7) Front flange

(a) Galling not exceeding 0.010in. (2,54 mm.) in depth. Repair in accordance with FRS.3253 (Ref. 70-42-11).

(b) Galling in excess of (a). Reject.

(c) Minor distortion. Repair in accordance with FRS.3253 (Ref. 70-42-11).

(d) Severe distortion. Reject.

2. Inspect Transition Case

A. Inspect transition case

(1) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS

Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref.78-30-00)

(2) Remove the following access panels (Ref. 72-03-00)

(a) Engines No.1 and 3

Turbine Section Lower Fairing 417A or 427A
Turbine Section L.H. Fairing 416BL or 426BL
Turbine Section R.H. Fairing 416BR or 426BR
Air Motor L.H. Access Panel 418DL or 428DL
Air Motor R.H. Access Panel 418DR or 428DR

(b) Engine No.2

Turbine Section Lower Fairing 437A
Turbine Section L.H. Fairing 436BL
Turbine Section R.H. Fairing 436BR
Air Motor L.H. Access Panel 438DL
Air Motor R.H. Access Panel 438DR

(3) Engines without S.B.72-4485, proceed as follows:

(a) Refer to fig.602, inspect outer stress skin for cracks, dents, scores and abrasions. For acceptance standards see 2.B.

(b) Inspect inner perforate skin for cracks, dents, scores and abrasions. For acceptance standards see 2.B.

(c) Inspect rear capping for cracks. For acceptance standards see 2.B.

(4) Engines with S.B.72-4485, proceed as follows:

(a) Refer to fig.603, inspect outer skin rear for dents, nicks and scores and cracks. For acceptance standards see 2.C.

(b) Inspect outer skin front for dents, nicks and scores and cracks. For acceptance standards see 2.C.

(c) Inspect inner perforate skin for dents, nicks and scores and cracks. For acceptance standards see 2.C.

(d) Inspect inner panel capping for dents, nicks and scores and cracks. For acceptance standards see 2.C.

(e) Inspect axial close-outs for dents, nicks and scores and cracks. For acceptance standards see 2.C.

(f) Inspect duct make-up piece for dents, nicks and scores and cracks. For acceptance standards see 2.C.

(g) Inspect front and rear flanges for galling and distortion. For acceptance standards see 2.C.

R (h) Inspect forward and rear close outs for cracks. For acceptance standards see 2.C.

(5) Fit panels (Ref.72-03-00) removed in operation (2).

(6) Unlock and reactivate thrust reverser system (Ref.78-30-00).

B. Acceptance standards - Engines without S.B.72-4485

(1) Outer stress skin

Cracks in outer stress skin are not acceptable. Refer to Approved Repairs (FRS.3698) for repair of cracks by welding.

Damage within the following limitations is acceptable.

(a) Smooth, round bottomed dents up to 0.125in. (3,175 mm.) deep and not exceeding 0.75in. (19,05 mm.) in length or width with a minimum distance of 10.00in. (254,00 mm.) between dents.

(b) Scores and abrasions providing the depth does not exceed 0.002in. (0.051 mm.) and the length does not exceed 2.00in. (50,80 mm.)

(2) Inner perforate skin

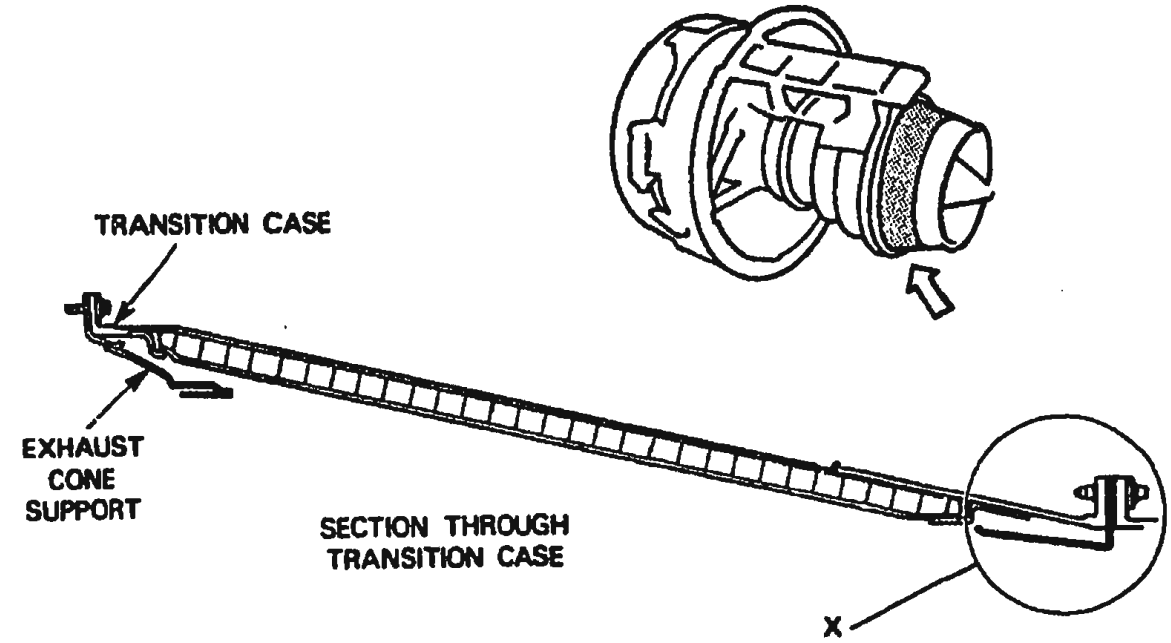
C (a) Axial cracks providing the length does not exceed
C 8 inches with a minimum distance between cracks
C of 1/2 inch. This applies to the early standard
C of duct which does not have the inner perforate
C segmented (M.0.95848).

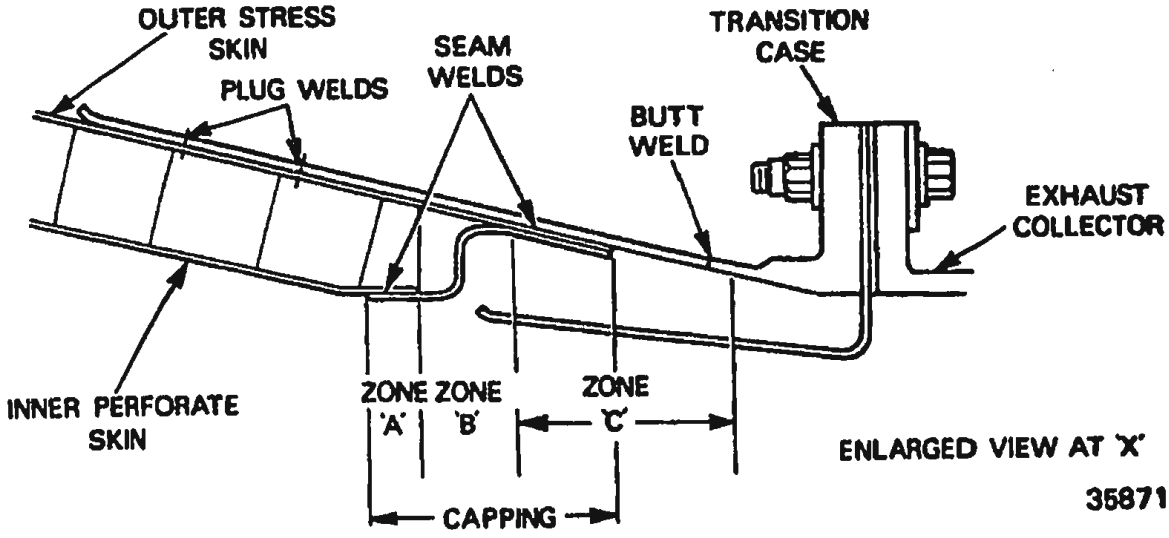
C (i) Axial cracks providing the length does not
C exceed 5 inches with a minimum distance
C between cracks of 1 inch. Applies to
C latest standard duct with segmented perforate
C panels (M.0.95848).

C NOTE: For repair of cracks outside
C acceptance standards refer to
C Approved Repairs (FRS.3697 or Engine
C Overhaul Manual, 72-54-00,
C Page Block 300).

(b) Axial cracks greater than 7.00in. (177,80 mm.) but less than 10.00in. (254,00 mm.) in length, stop weld each end of crack with a weld bead length of 0.50in. (12,70 mm.)(Ref. FRS.3697, Welding Data).

For repair of cracks outside acceptance standards, refer to Approved Repairs (FRS.3697).




R Transition case - Inspection/Check
R Fig.602

(c) Smooth, round bottomed dents up to 0.125in. (3,175 mm.) deep and not exceeding 0.75in. (19,05 mm.) in length or width with a minimum distance of 10.00in. (254,00 mm.) between dents.

(d) Scores and abrasions providing the depth does not exceed 0.002in. (0,051 mm.) and the length does not exceed 2.00in. (50,80 mm.)

(3) Capping

Cracks in Zone C (Ref.fig.602) are not acceptable. Refer to Approved Repairs (FRS.3697) for repair of cracks by welding.

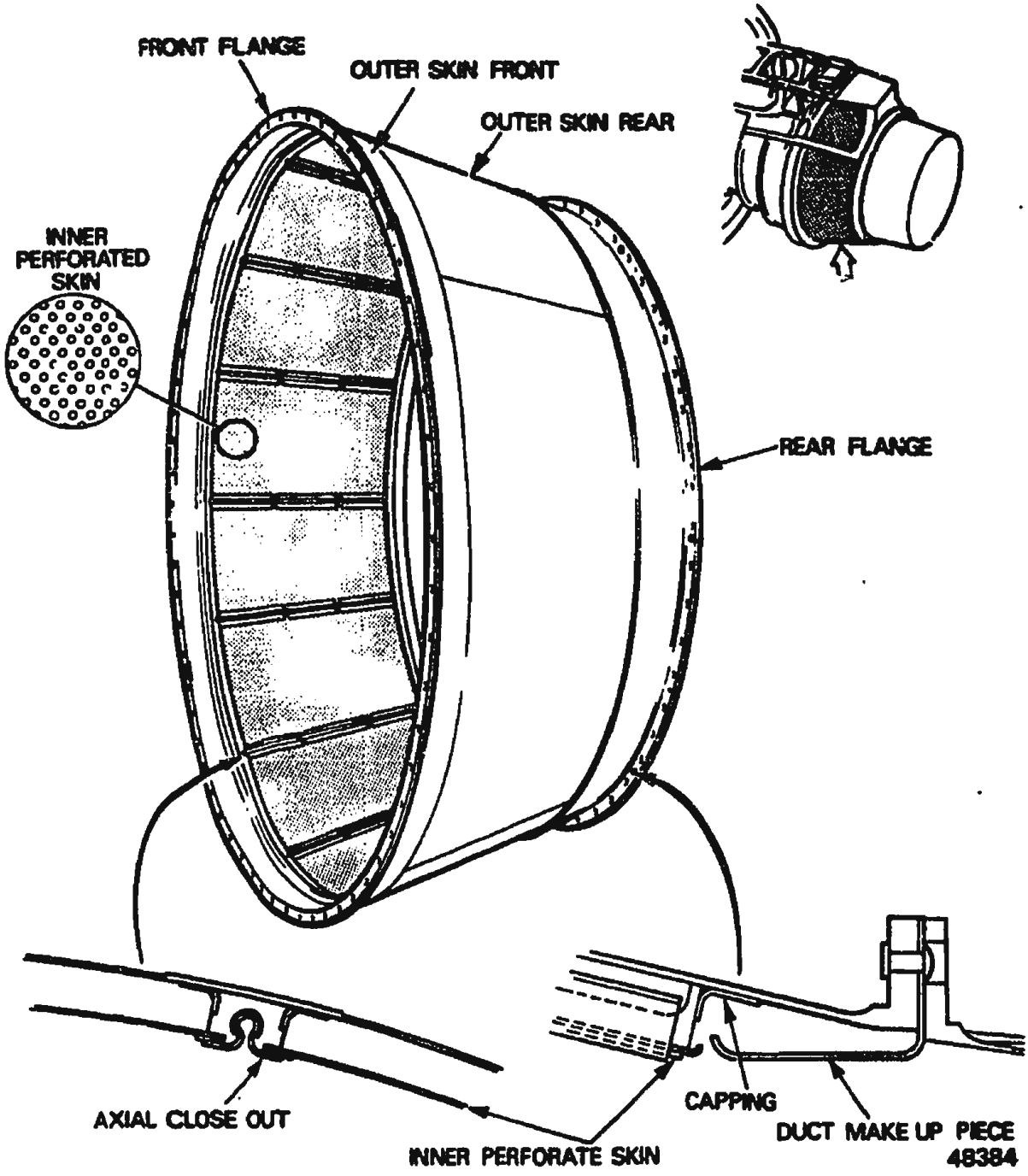
Damage within the following limitations is acceptable

(a) Zone A - Refer to fig.602, circumferential cracks providing the length does not exceed 6.00in. (152,4 mm.) and a minimum of 18.00in. (357,2 mm.) between cracks.

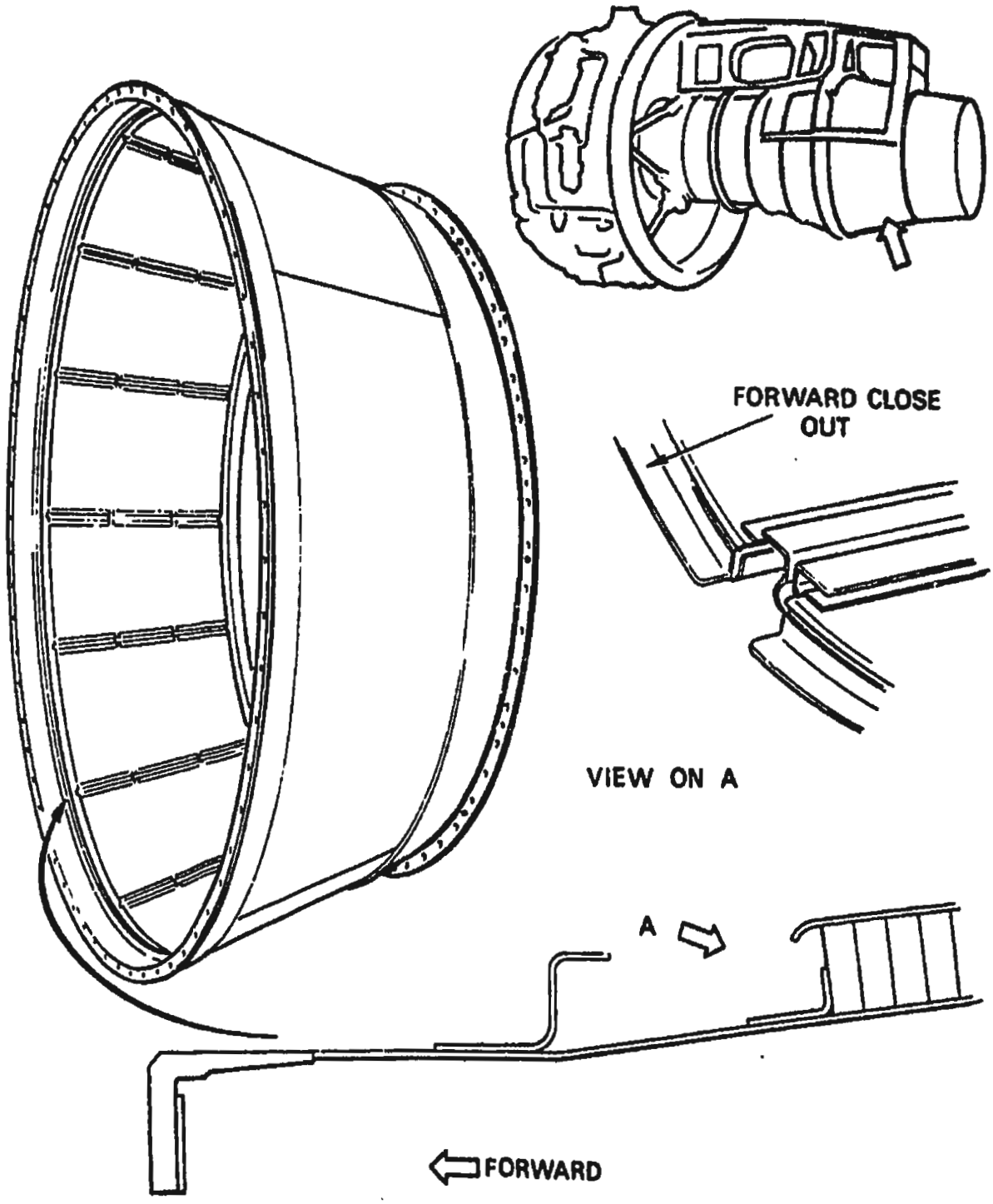
Circumferential cracks greater than 6.00in. (152,40 mm.) but less than 9.00in. (228,6 mm.) in length, stop weld each end of crack with a weld bead length of 0.50in. (12,7 mm.) (Ref. FRS.3697, Welding Data).

For repair of cracks outside acceptance standards, refer to Approved Repairs (FRS.3697).

C (b) Zone B - Refer to Fig.601, circumferential cracks providing the length does not exceed 6 inches and a minimum of two inches between cracks, over a 22 inch area. This limit supplies to the early standard of duct which does not have segmented inner perforate (M.0.95848). On segmented inner perforate standard circumferential cracks are allowed up to 6 inches in length with a minimum of 18 inches between cracks.




Transition case - Inspection/Check
Fig.603 (Sheet 1)




R Transition case - Inspection/Check
R Fig.603 (Sheet 2)

Circumferential cracks greater than 6.00in. (152,40 mm.) but less than 9.00in. (228,6 mm.) in length, stop weld each end of crack with a weld bead length of 0.50in. (12,7 mm.) (Ref. FRS.3697, Welding Data).

Axial cracks providing the length does not exceed 2.00in. (50,80 mm.) with a minimum circumferential distance of 18.00in. (357,2 mm.) between cracks.

For repair of cracks outside acceptance standards, refer to Approved Repairs (FRS.3697).

C. Acceptance standards - Engines with S.B.72-4485

(1) Outer skin rear

Cracks in outer skin rear are not acceptable.

Damage within the following limitations is acceptable:

(a) Smooth, crack free dents up to 0.125in. (3,175 mm.) deep and not exceeding 4.00in. (101,60 mm.) in diameter.

(b) Nicks and scores up to a depth of 0.003in. (0,76 mm.) provided they are crack free.

(2) Outer skin front

Cracks in outer skin front are not acceptable.

Damage within the following limitations is acceptable:

(a) Smooth, crack free dents up to 0.100in. (0,254 mm.) deep and not exceeding 2.00in. (50,80 mm.) in diameter.

(b) Nicks and scores up to a depth of 0.003in. (0,76 mm.) provided they are crack free.

(3) Inner perforate skin

(a) Smooth, crack free dents up to 0.125in. (3,175 mm.) deep and not exceeding 4.00in. (101,60 mm.) in diameter.

(b) Nicks and scores provided they are crack free.

(c) Axial cracks not exceeding 6.00in. (152,40 mm.) in length with a minimum of 1.00in. (25,40 mm.) of sound material between cracks.

(d) Circumferential cracks. Reject.

(4) Axial close-outs.

(a) Smooth, crack free dents.

(b) Nicks and scores provided they are crack free.

R (c) Cracked:

R (i) Individual cracks not more than 0.39in.
R (10 mm.) in length - Accept

R (ii) Individual cracks more than 0.39in. (10 mm.)
R in length - Reject.

(5) Duct make-up piece

(a) Smooth, crack free dents.

(b) Nicks and scores provided they are crack free.

(c) Axial cracks provided a minimum of 2.00in. (50,80 mm.) of sound material between cracks.

(d) Circumferential cracks. Reject.

(6) Front and rear flanges

(a) Galling not exceeding 0.010in. (2,54 mm.) in depth. Repair in accordance with FRS.3253 (Ref.70-42-11).

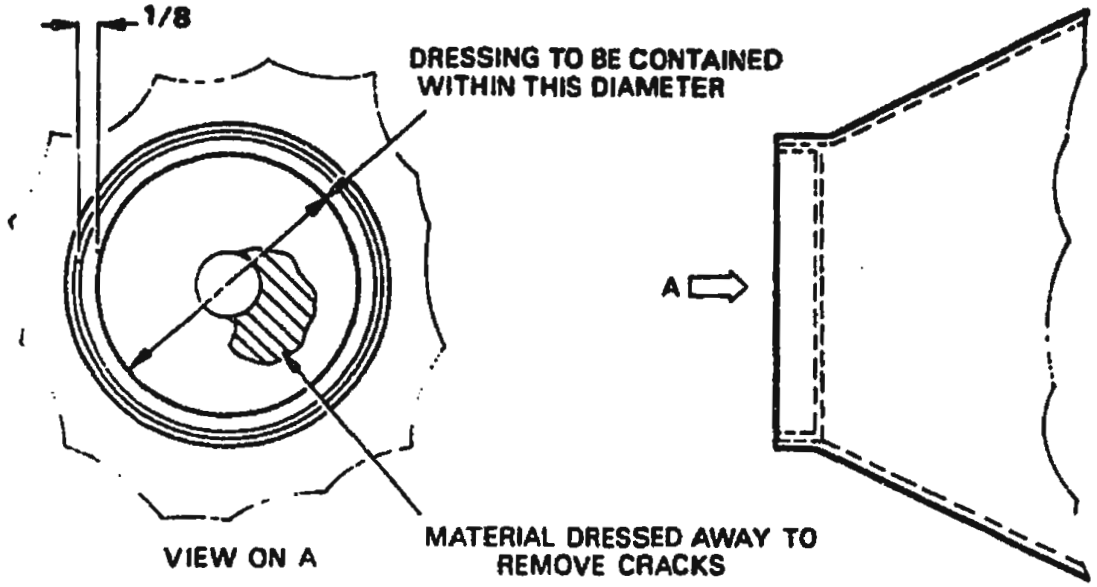
(b) Galling in excess of (a). Reject.

(c) Minor distortion. Repair in accordance with FRS.3253 (Ref.70-42-11).

(d) Severe distortion. Reject.

(7) Forward and rear close outs

R (a) Cracked/Missing. Accept




49230

C C Repair cracked exhaust cone by dressing Fig.604

3. Inspect Spoke Fairing Rear Support

A. Inspection

(1) WARNING: ENSURE THRUST REVERSER SYSTEM IS LOCKED IN FORWARD THRUST POSITION WHILE WORK IS IN PROGRESS.
Deactivate and tag thrust reverser and associated systems, and fit thrust reverser mechanical locks (Ref.78-30-00).

(a) Gain access to hot stream exhaust. Refer to Fig.605
R inspect Zone A for missing material, cracks and section protruding in to gas stream.

For acceptance standards see para.3.B.

(2) Unlock and reactivate thrust reverser and associated systems (Ref.78-30-00).

B. Acceptance standards

(1) Missing material

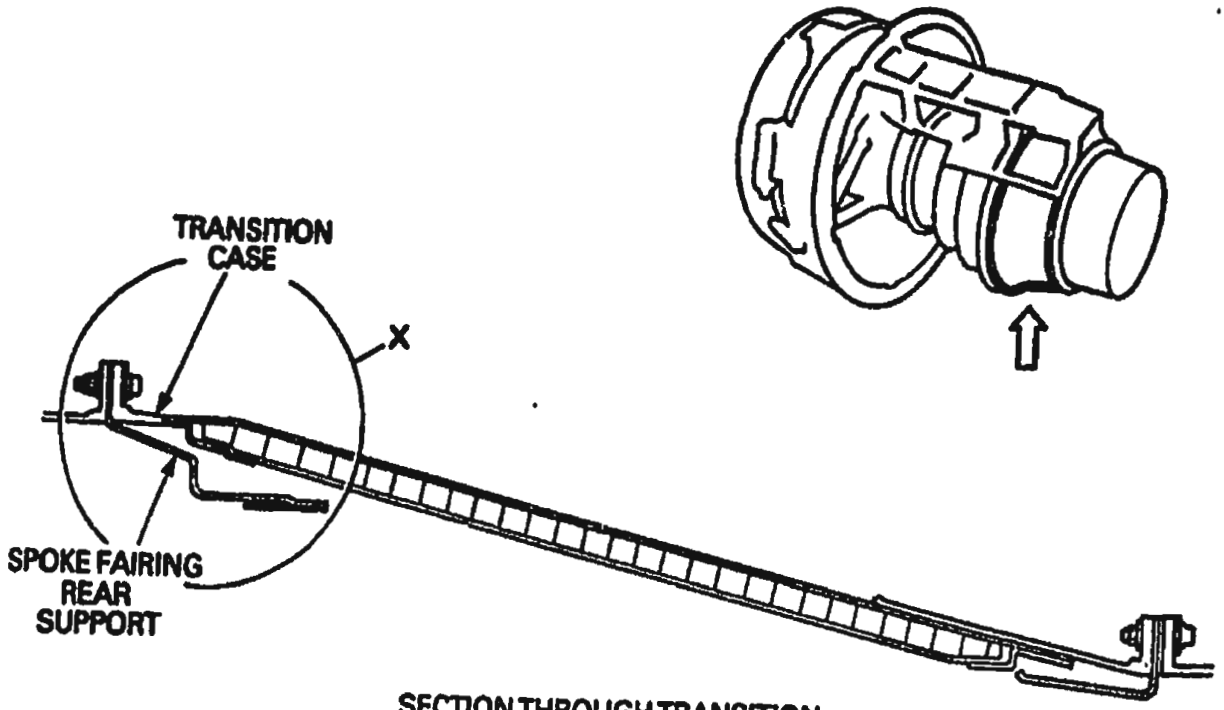
(a) Sections up to 3.00in. (76,20 mm.) in length
R circumferentially and 0.500in. (12,7 mm.) wide and a minimum distance of 8.00in. (203,20 mm.) from any adjacent missing sections are acceptable.

(2) Cracks

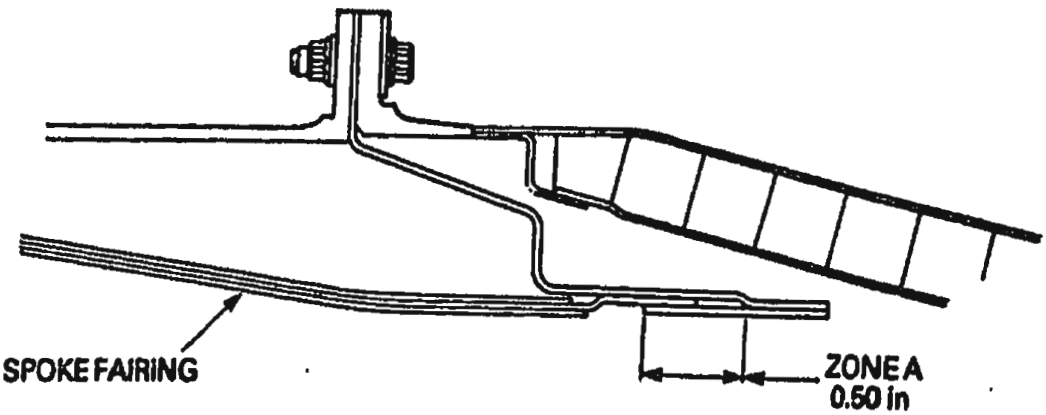
(a) Remove material providing the crack can be removed within limits specified in (1).

(3) Sections protruding in to gas stream.

(a) Soundly attached material distorted up to 0.100in. (2,54 mm.) from normal profile is acceptable.




SECTION THROUGH TRANSITION CASE




ENLARGED VIEW AT X

A2357

R Spoke fairing rear support - Inspection/Check
R Fig.605

## EXHAUST UNIT AND CONE - APPROVED REPAIRS

### LIST OF REPAIRS


| Repair No. | Title | Page No. |
|---|---|---|
| FRS.3652 | Exhaust cone - Perforate skin - Weld cracks and/or fit patches (Pre S.B.72-4822) | 803 |
| FRS.3697 | Transition case - Perforate skin and end cappings - Repair cracks by welding. | 807 |
| R FRS.3698 | Transition case - Outer skin adjacent to front and/or rear flange - Repair cracks by welding (Pre S.B.72-4485). | 817 |

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# EXHAUST CONE - PERFORATE SKIN - WELD CRACKS AND/OR FIT PATCHES

## (PRE S.B.72-4822)

## FRS.3652

### 1. Effectivity

| I.P.C. Fig./Item | Part No. |
|---|---|
| 01 075 | LK.41739 |

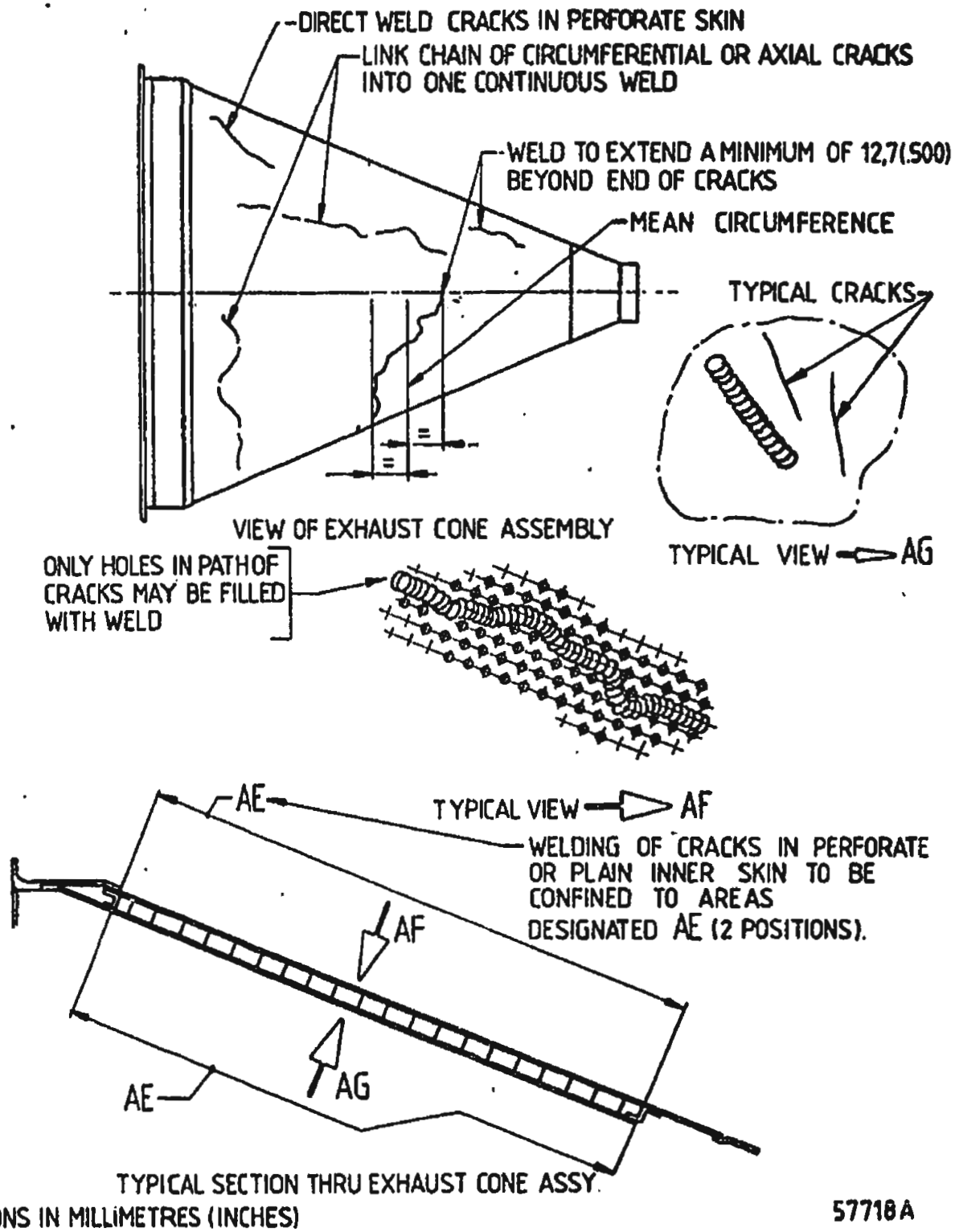
R This Repair covers: Repair of cracks by welding
R Repair of perforate skin by patching

### 2. Instructions

CAUTION: BEFORE WELDING ENSURE ADEQUATE FIRE PRECAUTIONS HAVE BEEN TAKEN.

A. Prepare and weld cracks

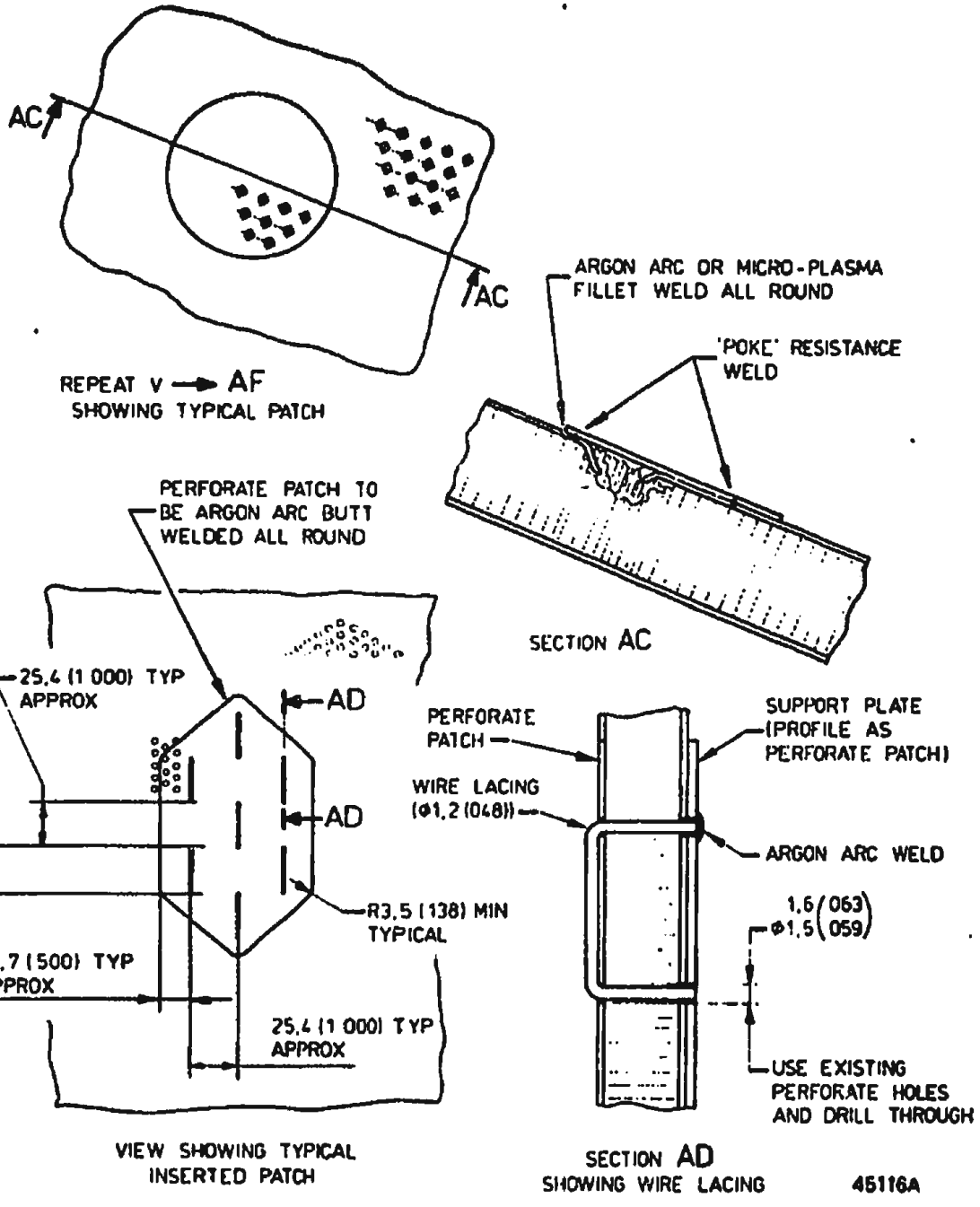
| Procedure | Supplementary Information |
|---|---|
| (1) Lightly planish the area around the crack if necessary | This operation is only necessary if there is an eruption of the material above the normal contour |
| (2) Clean the weld area | Tool: Smooth abrasive felt mop |
| (3) Degrease the area | T.S.D.594, O.P.101 C. Method 1 |
| (4) Tack weld the cracks at 12 mm. (0.50in.) intervals then complete the weld | See fig.801 and refer to 'Welding data' |
| (5) Visually inspect the weld | |
| (6) Vibro-engrave FRS.3652 adjacent to part number | |


DIRECT WELD CRACKS IN PERFORATE SKIN
LINK CHAIN OF CIRCUMFERENTIAL OR AXIAL CRACKS INTO ONE CONTINUOUS WELD
WELD TO EXTEND A MINIMUM OF 12,7(.500) BEYOND END OF CRACKS
MEAN CIRCUMFERENCE
TYPICAL CRACKS
VIEW OF EXHAUST CONE ASSEMBLY
TYPICAL VIEW AG
ONLY HOLES IN PATH OF CRACKS MAY BE FILLED WITH WELD
AE
TYPICAL VIEW AF
WELDING OF CRACKS IN PERFORATE OR PLAIN INNER SKIN TO BE CONFINED TO AREAS DESIGNATED AE (2 POSITIONS).
AF
AG
AE
TYPICAL SECTION THRU EXHAUST CONE ASSY.

DIMENSIONS IN MILLIMETRES (INCHES)

57718A

R R **Repair details and dimensions Fig.801**




R Repair details and dimensions
R Fig.802

R B. Fit surface patch

| R | | Procedure | Supplementary Information |
|---|---|---|---|
| R | (1) | Lightly planish area around patch, if necessary | This operation is only necessary if there is an eruption of material above normal contour |
| R | (2) | Cut patch | Minimum overlap on to undamaged perforate 3,175mm. (0.125in.) |
| R | (3) | Clean weld area | Tool: Smooth abrasive felt mop |
| R | (4) | Cold liquid degrease area | T.S.D.594, O.P.101, Method 1 |
| R | (5) | Fillet weld all round periphery of patch | See 4.A. Welding data<br>Use small plain pins through holes in patch and fairing skin to align perforations |
| R | (6) | Poke resistance stitchweld around damaged area and along crowns of honeycomb | See 4.B. Welding data |
| R | (7) | Remove locating pins | |
| R | (8) | Visually inspect walls | |
| R | (9) | Vibro-engrave FRS.3652/2 adjacent to part number | |

R C. Fit insert patch

| R | | Procedure | Supplementary Information |
|---|---|---|---|
| R | (1) | Mark out area of perforate skin to be removed | |
| R | (2) | Cut away defective skin | Ensure maximum weld line by cutting between perforations where possible |
| R | (3) | Cut perforate skin patch to fit aperture | Match up hole pattern where possible<br>See 6. Parts |
| R | (4) | Cold liquid degrease patch and weld areas of panel | T.S.D.594, O.P.101, Method 1 |
| R | (5) | Argon arc buttweld all round patch | See 4.A. Welding data |
| R | (6) | Cut support plate to same size as welded patch | See 6. Parts |
| R | (7) | Drill holes through existing perforations, cone inner wall and new support plate | See fig.802 for typical hole pattern<br>Use 1,58mm. (0.062in.) drill |
| R | (8) | Degrease support plate | T.S.D.594, O.P.101 |
| R | (9) | Position support plate on inner wall and pass lengths of wire through holes | See fig.802.<br>Use 18/8 stainless wire, 18 S.W.G., OMat 306 |

R (10) Draw wire tight against
R support plate and secure
R by fusing ends to plate
R See fig.802
R See 4.A. Welding data.
R Filler is not required

R (11) Visually inspect all wire
R securing welds

R (12) Dye penetrant crack test
R repair welds
R Routine overhaul procedure

R (13) Vibro-engrave FRS.3652/3
R adjacent to part number

3. Material of Component

| | R.R. Symbol | Material |
|---|---|---|
| Perforate skin | EBM | 18/8 Stainless Steel |

4. Welding Data

A. Argonarc

Type of weld .. .. Argonarc D.C. output

Torch .. .. .. .. BOC W200, water cooled, or equivalent

Filler wire .. .. .. 24 S.W.G. (0.022in.)
BS 2901 A8 Nb
OMat, 306

Electrode .. .. .. 1,574 mm. (0.062in.) diameter thoriated tungsten ground to a point

Argon flow .. .. .. 10 to 15 CFH

Current .. .. .. 10 to 15 AMP

R This data is given for guidance, for further information refer
R to T.S.D.594, O.P.409

R B. Poke resistance

| | | |
|---|---|---|
| R | Type of weld .. .. | Poke resistance |
| R R | 'Incorporall' portable welding kit settings | Control panel connection 3 Timer set at 5 |

R 5. Tools

| | | |
|---|---|---|
| R R R R R R | Incorporall portable welding kit | Supplied by: Delaney Galley Ltd., Vulcan Works, Edgeware Road, London, N.W.2. England |

R 6. Parts

R A. Parts required

| | I.P.C. Fig./Item | Part No. | Description |
|---|---|---|---|
| R R R R R R | | LK47399 | Perforate patch material 558,80 mm. x 660,40 mm. (22in. x 26in.) |
| | | BR50909 | Patch material 609,60 mm. x 609,60 mm. (24in. x 24in.) |

7. Price and Availability

R Engine parts ) Repair of spares ) Refer to Rolls-Royce plc

# TRANSITION CASE - PERFORATE SKIN AND END CAPPINGS - REPAIR CRACKS BY WELDING OR PATCHING (PRE S.B.72-4485)

## FRS.3697

This Repair covers: (1) Welding of cracks
(2) Patching cracked front end cappings

## 1. Effectivity

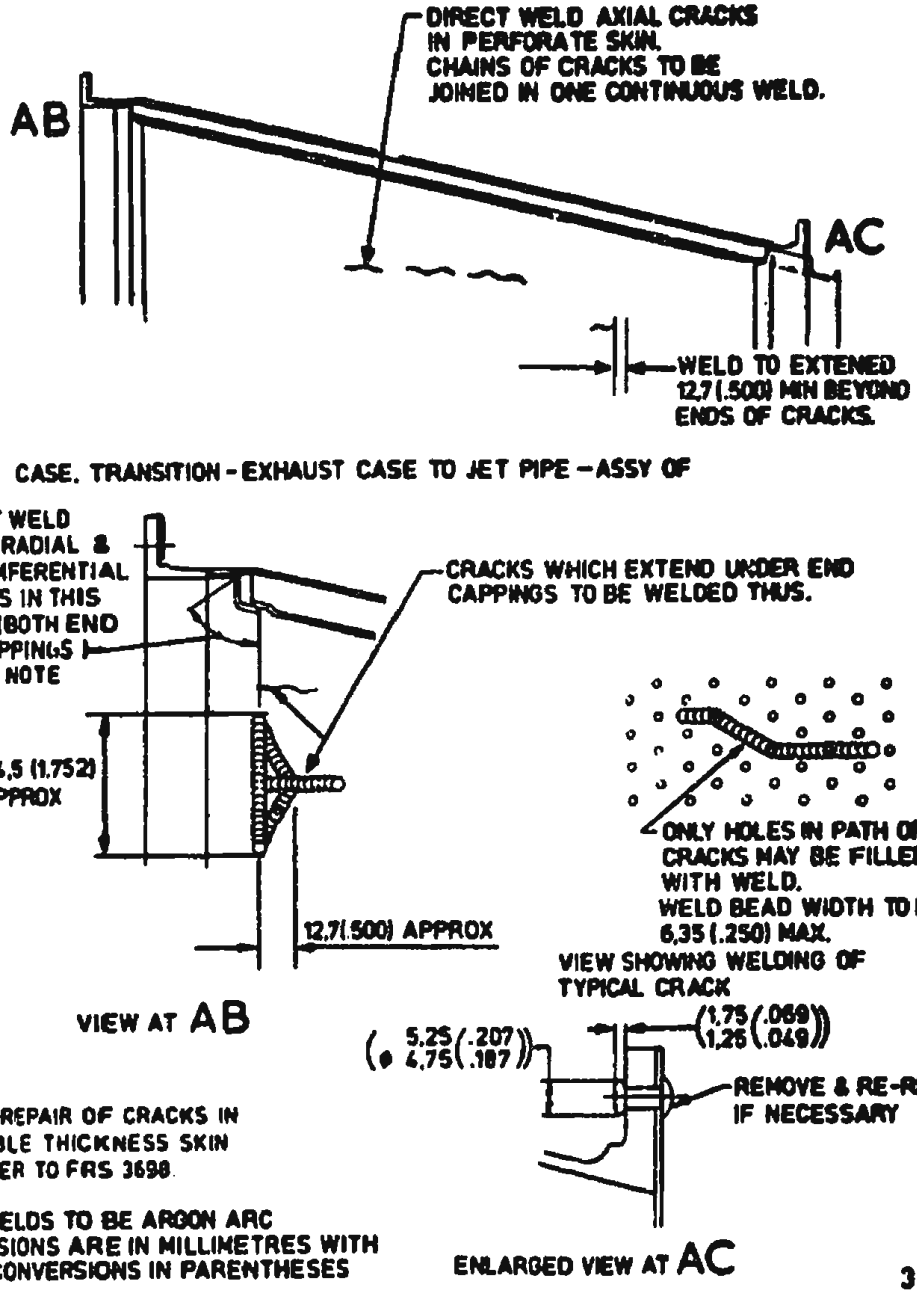
| I.P.C. Fig./Item | Part No. | |
|---|---|---|
| 01 550 | LK38091 | |
| | LK53462 | S.B.78-2969 |
| | LJ30777 | S.B.78-3536 Part 1 |
| | LJ30775 | S.B.78-3536 Part 2 |
| | LK63536 | S.B.72-3737 |

## 2. Instructions

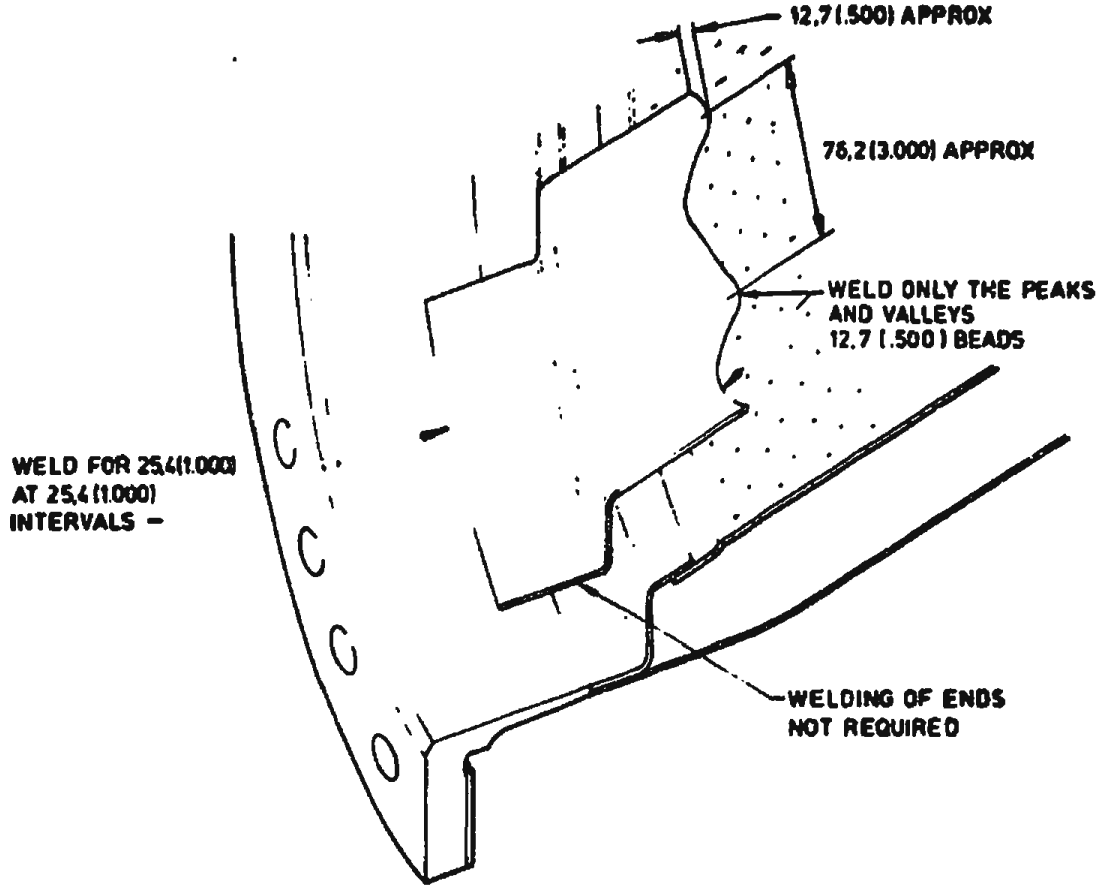
CAUTION: BEFORE WELDING ENSURE ADEQUATE FIRE PRECAUTIONS HAVE BEEN TAKEN.

### A. Prepare and weld cracks

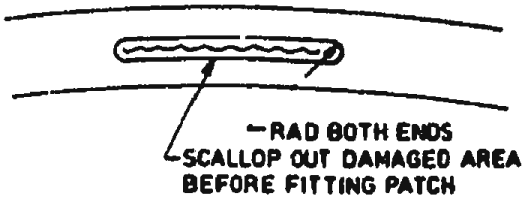
| | Procedure | Supplementary Information |
|---|---|---|
| (1) | To gain access to cracks in the rear capping dress off the rivet heads and remove the rear shrouds. | Tools: Rotary cutter or grinder<br>See fig.803 |
| (2) | Lightly planish the area around the crack if necessary. | Only if the material has lifted above the normal contour |
| (3) | Clean the weld area | Tool: Smooth abrasive felt mop |
| (4) | Degrease the area | T.S.D.594, O.P.101, C. Method 1. |


DIRECT WELD AXIAL CRACKS IN PERFORATE SKIN. CHAINS OF CRACKS TO BE JOINED IN ONE CONTINUOUS WELD.
AB
AC
WELD TO EXTENED 12.7 (.500) MIN BEYOND ENDS OF CRACKS.
CASE, TRANSITION - EXHAUST CASE TO JET PIPE - ASSY OF
DIRECT WELD AXIAL, RADIAL & CIRCUMFERENTIAL CRACKS IN THIS AREA (BOTH END CAPPINGS) & SEE NOTE
CRACKS WHICH EXTEND UNDER END CAPPINGS TO BE WELDED THUS.
44,5 (1.752) APPROX
12.7 (.500) APPROX
VIEW AT AB
ONLY HOLES IN PATH OF CRACKS MAY BE FILLED WITH WELD.
WELD BEAD WIDTH TO BE 6,35 (.250) MAX.
VIEW SHOWING WELDING OF TYPICAL CRACK
5.25 (.207)
4.75 (.187)
1.75 (.069)
1.25 (.049)
REMOVE & RE-RIVET IF NECESSARY
NOTE
FOR REPAIR OF CRACKS IN DOUBLE THICKNESS SKIN REFER TO FRS 3698
ALL WELDS TO BE ARGON ARC
DIMENSIONS ARE IN MILLIMETRES WITH INCH CONVERSIONS IN PARENTHESES
ENLARGED VIEW AT AC
35358A

Repair details
Fig.803


12,7 (.500) APPROX
76,2 (3.000) APPROX
WELD ONLY THE PEAKS AND VALLEYS 12,7 (.500) BEADS
WELD FOR 25,4 (1.000) AT 25,4 (1.000) INTERVALS
WELDING OF ENDS NOT REQUIRED

VIEW SHOWING PATCHING ON THE END CAPPING




38477

View on end capping
Fig.804

| Procedure | Supplementary Information |
|---|---|
| (5) Tackweld the cracks at 12 mm. (0.500in.) intervals then complete the weld | See fig.803 and refer to 4. Welding Data |
| (6) Penetrant crack test | T.S.D.594, O.P.213 or 218 |
| (7) Inspect the weld | |
| (8) Check for distortion | Refer to 5. Acceptance Standards |
| (9) Replace the rear shrouds and fit rivets | Tool: Rivet clamps. See fig.802 |
| (10) Vibro-engrave FRS.3697 adjacent to the part number | |

B. Fit doubler patch

| Procedure | Supplementary Information |
|---|---|
| (1) Scallop out damaged material and remove any weld beads | See fig.804<br>Use hand tools |
| (2) Lightly planish repair area to original contour | Use hand tools |
| (3) Cut and form doubler patches as necessary | See fig.804 |
| (4) Clean the weld area | Tool: Smooth abrasive felt mop |
| (5) Degrease the weld area and patch | T.S.D.594, O.P.101, Method 1 |

| | Procedure | Supplementary Information |
|---|---|---|
| (6) | Tackweld doubler in position | See fig.804 and 4. Welding data |
| (7) | Bolt steel support ring to front flange to minimise distortion | Tool: Local manufacture Ring arm section 12,7 mm. (0.500in. x 50,8 mm. (2.00in.) approximately). |
| (8) | Complete argonarc welding | See fig.803 and 4. Welding data |
| (9) | Penetrant crack test | T.S.D.594, O.P.213 or 218 |
| (10) | Doubler fitted at six o'clock position will require restoration of existing drain holes | Use hand tools |
| (11) | Effect an assembly check to ensure that the mating part does not foul the doubler patch | Lightly planish if an interference exists |
| (12) | Check for distortion | Refer to 5. Acceptance standard |
| (13) | Vibro-engrave FRS.3697/1 adjacent to part number. | |

3. Material of Component

| Description | R.R. Symbol | Material |
|---|---|---|
| Perforate skin | EBM | 18/8 Stainless Steel |
| End Capping | - | 18/8 Stainless Steel |

4. Welding data

| | |
|---|---|
| Type of Welding .. .. | Argonarc DC |
| Filler Material .. .. | 24 S.W.G. (0.022in. diameter)<br>B.S. 2901 A8 Nb<br>R.R. Specification<br>M.S. 950/2 OMat 306<br>or alternatively<br>A.I.S.I. Type 347 may be used |
| Torch .. .. .. .. | B.O.C. W200 or any 200 Amp. capacity water cooled equivalent |
| Electrode .. .. .. | 2 per cent thoriated tungsten 0.093in. diameter |
| Current .. .. .. | To be determined by operator |
| Shield .. .. .. | Ceramic (0.625in. bore) fitted with gas lens |
| Argon flow .. .. .. | 15 to 20 CFH |

This information is for guidance, optimum settings must be determined by welding test pieces. For further information refer to T.S.D.594, O.P.409.

5. Acceptance Standards

A. Weld Distortion

(1) Ovality

The case is acceptable provided that it can be fitted to its mating component and undue force is not required to fit the engine bolts.

(2) Flatness of flange faces

A maximum gradual deviation of 0.020in. from normal is acceptable.

6. Tools

Support ring for use when patching - Local manufacture.

## 7. Parts

### A. Parts required

| I.P.C. Fig./Item | Part No. | Description |
|---|---|---|
| | AS16090 | Rivet |
| | BR45320 | Patching material |

## 8. Price and availability

R Repair of spares - Refer to Rolls-Royce plc

# TRANSITION CASE - OUTER SKIN ADJACENT TO FRONT AND/OR REAR FLANGE - REPAIR CRACKS BY WELDING (PRE S.B.72-4485)

## FRS.3698

This Repair covers:

Direct welding of cracks either in or adjacent to the existing circumferential or axial construction welds.

NOTE: This scheme does not cover repair to the rear flange on S.B.72-3536 standard (Transition case with improved butt welded rear flange).

## 1. Effectivity

| I.P.C. Fig./Item | Part No. | |
|---|---|---|
| 01 550 | LK38091 | |
| | LK53462 | S.B.78-2969 |
| | LK30777 | S.B.72-3536 Part 1 |
| | LK30775 | S.B.72-3536 Part 2 |

## 2. Instructions

CAUTION: BEFORE WELDING ENSURE ADEQUATE FIRE PRECAUTIONS HAVE BEEN TAKEN.

A. Prepare and weld cracks

| | Procedure | Supplementary Information |
|---|---|---|
| (1) | Dress off rivet heads and remove the rear shrouds | Tool: Rotary cutter or grinder<br>See fig.805 |
| (2) | Clean the weld area and vee out the cracks | Tool: Smooth abrasive felt mop and rotary files<br>See fig.805 |
| (3) | Degrease the weld area | |
| (4) | Weld cracks | Use Argon backing. See fig.804 and 4. Welding data |
| (5) | Dress weld underbead flush to the adjacent surface | Tool: Hand grinding equipment |
| (6) | Penetrant crack test | T.S.D.594, O.P.213 or 218 |
| (7) | Inspect the weld | T.S.D.594, O.P.409<br>3. Inspection |
| (8) | X-Ray inspect the weld | See 5. Acceptance Standard |
| (9) | Check for distortion | See 5. Acceptance Standard |
| (10) | Replace the rear shrouds and fit rivets | Tool: Rivet clamp<br>See fig.805 |
| (11) | Vibro-engrave FRS.3698 adjacent to the part number | |

## 3. Material of Component

| | R.R. Symbol | Material |
|---|---|---|
| Stress skin | - | 18/8 Stainless Steel |
| End Capping | - | 18/8 Stainless Steel |

## 4. Welding Data

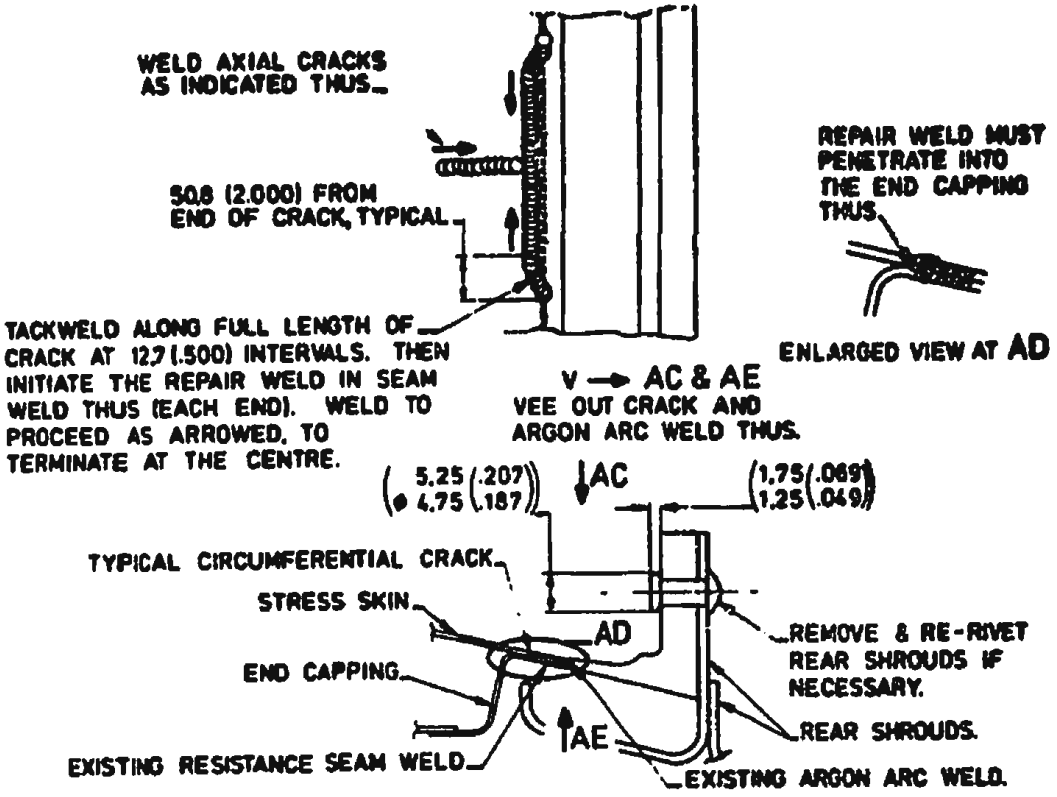
| | |
|---|---|
| Type of welding .. .. | Argonarc D.C. |
| Filler Material .. .. | 24 S.W.G. (0.022in. diameter) B.S. 2901 A8 Nb RR Specification MS950/2 OMat 306 or alternatively A.I.S.I. Type 347 may be used. |
| Torch .. .. .. .. | B.O.C. W200 or any 200 Amp capacity water cooled equivalent |
| Electrode .. .. .. | 2 per cent thoriated tungsten 0.093in. diameter |
| Current .. .. .. | To be determined by operator |
| Shield .. .. .. | Ceramic (0.025in. bore) fitted with gas lens |
| Gas Flow (Torch and Backing) .. .. .. | 20 to 25 CFH |

This information is for guidance, optimum settings must be determined by welding test pieces. For further information refer to T.S.D.594, O.P.409.

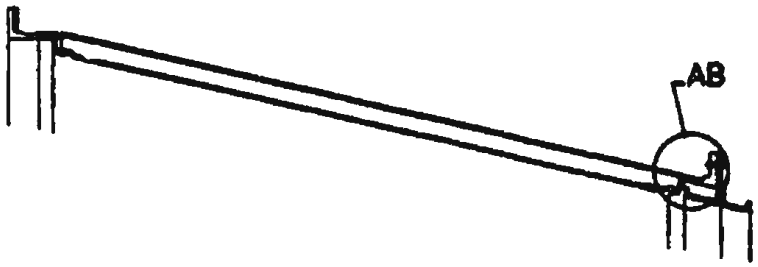
## 5. Acceptance Standard

### A. X-Ray Inspection

Accept porosity and tungsten inclusion in accordance with standards given in T.S.D.594, O.P.409 for low carbon molybdenum sheets. Faults other than these are not acceptable.


WELD AXIAL CRACKS AS INDICATED THUS
50.8 (2.000) FROM END OF CRACK, TYPICAL
TACKWELD ALONG FULL LENGTH OF CRACK AT 12.7 (.500) INTERVALS. THEN INITIATE THE REPAIR WELD IN SEAM WELD THUS (EACH END). WELD TO PROCEED AS ARROWED, TO TERMINATE AT THE CENTRE.
REPAIR WELD MUST PENETRATE INTO THE END CAPPING THUS
ENLARGED VIEW AT AD
V → AC & AE
VEE OUT CRACK AND ARGON ARC WELD THUS.
5.25 (.207)
4.75 (.187)
AC
1.75 (.069)
1.25 (.049)
TYPICAL CIRCUMFERENTIAL CRACK
STRESS SKIN
AD
END CAPPING
AE
EXISTING RESISTANCE SEAM WELD
REMOVE & RE-RIVET REAR SHROUDS IF NECESSARY.
REAR SHROUDS.
EXISTING ARGON ARC WELD.

ENLARGED VIEW AT AB




SECTION THROUGH CASE, TRANSITION – EXHAUST CASE TO JET PIPE ASSY.

ALL WELDS TO BE ARGON ARC.
DIMENSIONS ARE IN MILLIMETRES WITH INCH CONVERSIONS IN PARENTHESES

36386

Repair details
Fig.805

B. Weld Distortion

(1) Ovality

The case is acceptable provided that it can be fitted to its mating component and undue force is not required to fit the engine bolts.

(2) Flatness of flange faces

A maximum gradual deviation of 0.020in. from normal is acceptable.

6. Tools

Special tools are not required.

7. Parts

A. Parts required

| I.P.C. Fig./Item | Part No. | Description |
|---|---|---|
| | AS.16090 | Rivet |

8. Price and Availability

R Repair of Spares - Refer to Rolls-Royce plc

## ACCESSORY SECTION - SERVICING

R **WARNING** : THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE MAY CAUSE IRRITATION IF SKIN CONTACT IS REPEATED OR PROLONGED.

**CAUTION** : 1. THE OIL SPECIFIED FOR USE IN THIS OIL SYSTEM IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS OF THE ENGINE NOT NORMALLY IN CONTACT WITH IT. ANY OIL SPILT DURING SERVICING MUST BE WIPED UP IMMEDIATELY.

2. CONTAMINATION BY MINUTE AMOUNTS OF CERTAIN ALKALINE CLEANING FLUIDS CAN CAUSE COMPLETE BREAKDOWN OF THE SYNTHETIC OIL. USE SCRUPULOUSLY CLEAN CONTAINERS AND EQUIPMENT.

Service Bulletins referred to:

Teleflex S.B.28906-73-1 - Introduction of Baulking Peg for Hand Cranking Cover
72-4763 - Input Drive Bevel Gears Housing with Solid Inserts at Hand Turning Access Point

R Referenced Procedures

R 12-12-01 - Engine Oil Replenishment
R 70-02-01 - Identification Lubrication and Fitting of Rubber Sealing Rings
R 71-00-00 - Power Plant - Adustment Test
R 71-11-00 - Cowlings Engines No.1 and 3 - Servicing
R 71-12-01 Hinged Cowl, LH and RH Lower - Servicing

R Illustrated Parts Catalogue References

R The I.P.C. sections where parts disturbed during the following R operations can be located are as follows:-

R 72-61-41 - H.S. Gearbox Oil Tank Cover Fittings
R 76-11-10 - Engine Power and T'R Control Linkage Fuel Flow Regulator F.T.C.S. Box and Fittings

## 1. Oil Prime Internal, Intermediate and External Gearboxes

CAUTION : THE FOLLOWING PROCEDURE MUST BE CARRIED OUT ON ANY ENGINE WHICH HAS HAD THE OIL SYSTEM DRAINED PRIOR TO OIL FILLING AND DRY MOTORING CYCLES TO AVOID POSSIBLE SCUFFING OF THE GEARS.

A. Equipment required:

| | |
|---|---|
| U.999092 | Hose |
| UT.1145 | Adapter and coupling assembly (Aeroquip coupling) |
| UT.954 | Adapter and coupling assembly (Ozone coupling) |
| 3409536 | Oil gun |

B. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Lockwire | DTD.189A 22 S.W.G. | 21 A.W.G. | 238 |

Clean engine oil (Ref.12-12-01)

C. Open left-hand hinged cowl 413A or 423A for engines No.1 and 3 (Ref. 71-11-00), or 433AL for engine No.2 (Ref. 71-12-01).

D. Refer to fig.301, remove cap nut (1) from oil priming connector adjacent to oil pressure filter.

E. Remove 'Ozone' or 'Aeroquip' coupling from adapter and coupling assembly.

F. With adapter attached to hose and hose attached to oil gun, connect adapter to oil priming connector.

G. Inject 10 Imperial pints (12 U.S. pints, 5.7 litres) of clean engine oil into engine.

H. Disconnect adapter from oil priming connection; refit 'Ozone' or 'Aeroquip' coupling to adapter.

J. Fit cap nut (1) to oil priming connection and wirelock.

K. Close left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00), or 433AL for engine No.2 (Ref. 71-12-01).

R L. Perform Oil leak Test No.2 (Ref.71-00-00).

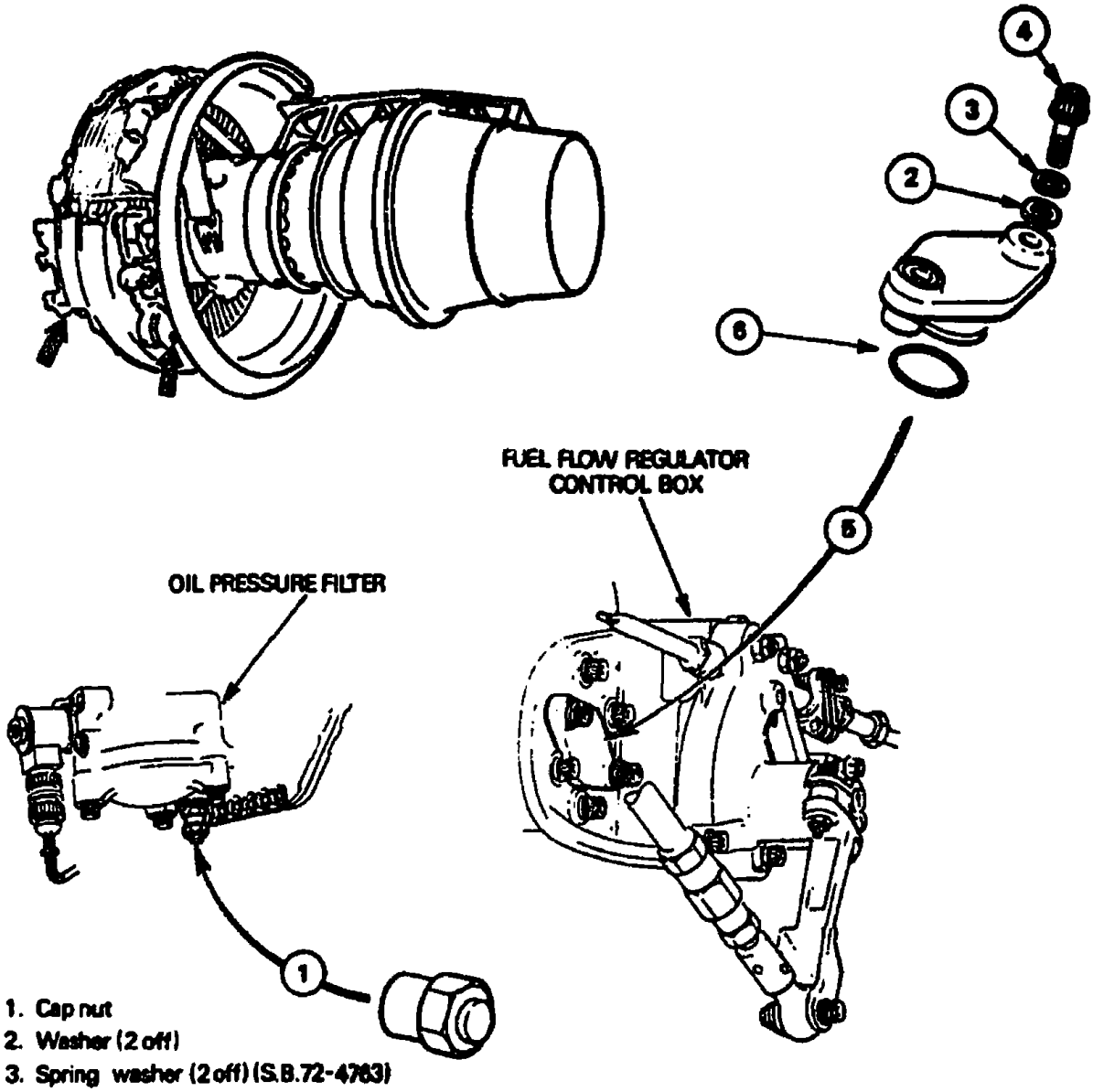
2. Oil Prime High-Speed External Gearbox Input Drive Bevel Gears

A. Equipment required:

Syringe - nozzle outside diameter 0.3125in. (7,9375 mm.)

B. Material required:

Clean engine oil (Ref. 12-12-01)




1. Cap nut
2. Washer (2 off)
3. Spring washer (2 off) (S.B.72-4763)
4. Bolt (2 off)
5. Cover
6. Seal ring

259738

Oil priming points
Fig.301

C. Open left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00), or 433AL for engine No.2 (Ref. 71-12-01).

D. Refer to fig.301, on units not incorporating S.B.72-4763 remove bolts (4), washers (2) and cover (5).

On units incorporating S.B.72-4763, remove bolts (4), washers (3) and (2) and cover (5).

E. Insert syringe nozzle into oil trough spout and inject 1.5 Imperial pints (2 U.S. pints, 1 litre) of clean engine oil into trough; remove syringe.

NOTE : The oil trough spout is visible towards the top of access cover aperture.

F. Fit and lubricate (Ref. 70-02-01) new seal ring (6) to access cover (5).

G. On fuel flow regulator boxes incorporating Teleflex S.B.28906-73-1, position access cover on fuel flow regulator box.

On fuel flow regulator boxes not incorporating Teleflex S.B.28906-73-1, position access cover on fuel flow regulator box, ensuring positive location of hollow dowel.

H Refer to fig.301, on units not incorporating S.B.72-4763, fit and secure washer (2) and bolts (4).

On units incorporating S.B.72-4763, fit and secure washers (2) and (3) and bolts (4).

J. Close left-hand hinged cowl, 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433AL for engine No.2 (Ref. 71-12-01).

K. Replenish engine oil tank (Ref. 12-12-01).

R L. Perform Oil Leak Test No.2 (Ref.71-00-00).

C HIGH SPEED EXTERNAL GEARBOX DRIVE HOUSING - REMOVAL/INSTALLATION
STEP ASIDE GEARBOX MODULE 03/2

C 1. General (See M11-72-46 for sign off)

For standard torque loadings and torque tightening technique, refer to 70-51-00.

Special torque loadings and assembly tolerances are detailed at the appropriate stage in the procedure.

Discard all rubber seal rings, cotter pins and key washers during removal sequence.

For identification, lubrication and fitting of rubber sealing rings, refer to 70-02-01.

2. Removal/Installation High Speed External Gearbox Drive and Housing

WARNING: THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE MAY CAUSE IRRITATION IF SKIN CONTACT IS REPEATED OR PROLONGED.

CAUTION:
1. THE OIL SPECIFIED FOR USE IN THIS ENGINE IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS NOT NORMALLY IN CONTACT WITH OIL. SPILT OIL MUST BE WIPED AWAY IMMEDIATELY.

2. ENSURE ELECTRICAL CONNECTORS ARE FREE FROM LIQUID AND/OR SOLID CONTAMINATION BEFORE CONNECTING OR DISCONNECTING. FAILURE TO DO SO CAN RESULT IN A FIRE.

3. THE BEVEL BOX WEIGHS APPROXIMATELY 31 LB. (14 KG).

Service Bulletins referred to:

75-2042 - H.P. compressor bleed valve with re-run air tubes
72-2399 - Compressor intermediate case - Introduction of seal ring between drive housing and intermediate case
72-2435 - H.S. gearbox drive shaft outer tube with location check markings
72-2560 - Replacement of D-headed bolts with bihexagonal bolts
72-2946 - Transfer drive tube with quadrant clamp retainer
72-3158 - Improved retention and lubrication of drive quillshaft
72-4402 - Bevel box to intermediate case, introduction of steady brackets
72-4547 - External gearbox - Improved sealing between drive housing and external gearbox
72-4685 - Upper bevel gear housing with steel neck adapter
72-5127 - Bevel box hexagon headed retaining bolts
R 72-7443 - Improved spline lubrication and shaft retention with
R spiral ring weir

Referenced Procedures:

70-51-00 Torque Tightening Techniques
70-02-01 Identification, Lubrication and Fitting of Rubber Sealing Rings
71-00-00 Power Plant - Adjustment/Test
72-03-00 Gas Generator Fairings - Removal/Installation

C 3. Prepare to remove bevel box (Step Aside Gearbox)

C A. DELETED

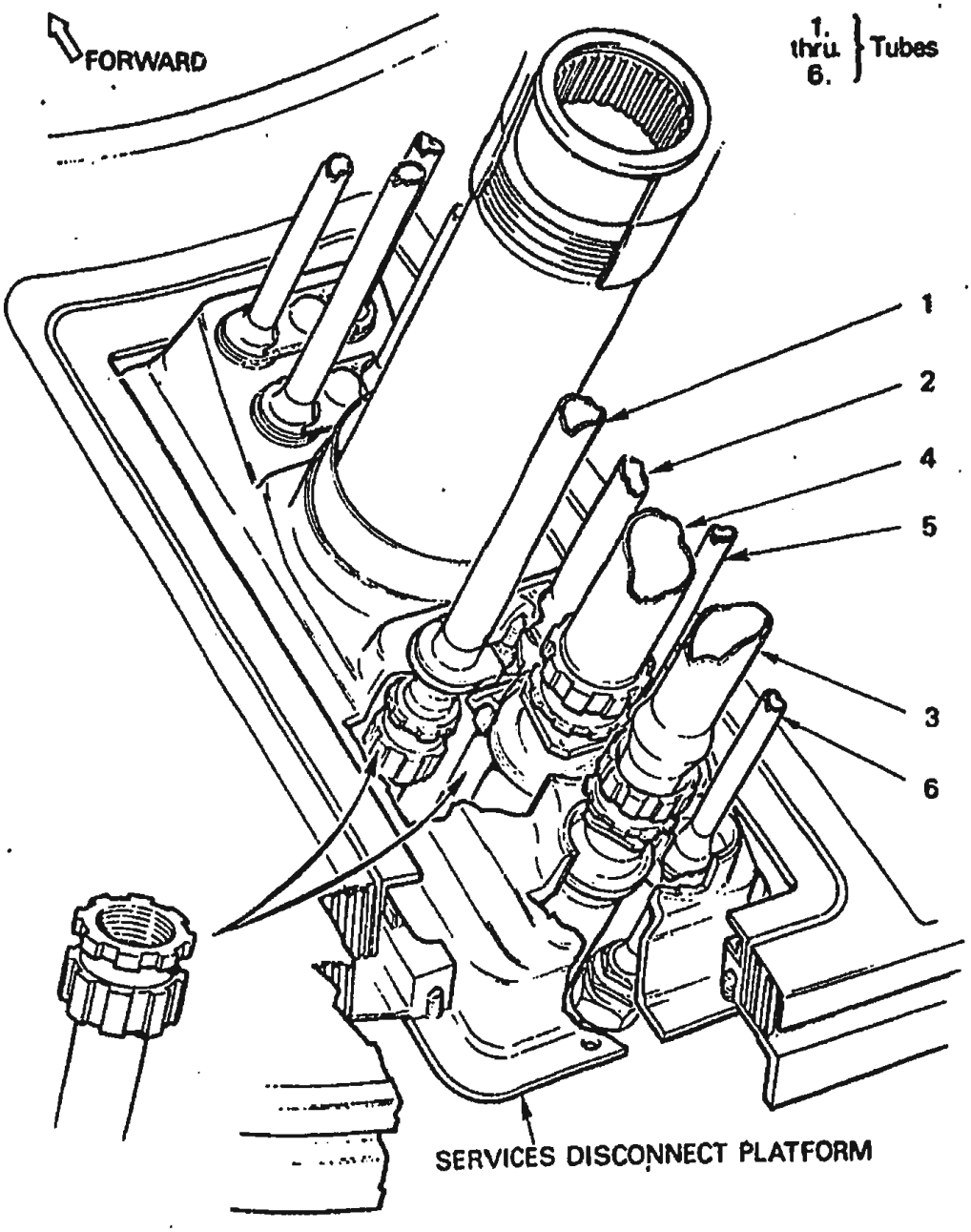
B. Remove compressor section fairings

(1) Remove compressor section rear left-hand and right-hand fairings (Ref. 72-03-00).

(2) Remove compressor section lower left-hand and right-hand fairings (Ref. 72-03-00).

C. Disconnect tubes (1) and (2), fig.401

NOTE: This operation is necessary to allow the transfer drive tube to be disconnected.




R Disconnect/Connect tubes at services disconnect platform
R Fig.401

D. Disconnect transfer drive tube and quillshaft

NOTE: S.B.72-2946 refer to fig.402 (Sheet 1)
S.B.72-3158 refer to fig.402 (Sheet 2)
R S.B.72-7443 refer to fig.402 (Sheet 3)

R (1) Engine with S.B.72-2946, S.B.72-3158 and S.B.72-7443 remove bolts (1) securing tube retaining segment.

(2) Break stick of seals using 'C' wrench.

(3) Push transfer drive tube in towards centre of engines to expose quillshaft locating plate and securing details. Care must be exercised not to damage the seal carrier section of the input drive bevel gear assembly.

C CAUTION: DO NOT DAMAGE LOWER HOUSING BY PRYING. USE
C SOFT METAL DRIFT TO RAISE DRIVE TUBE.

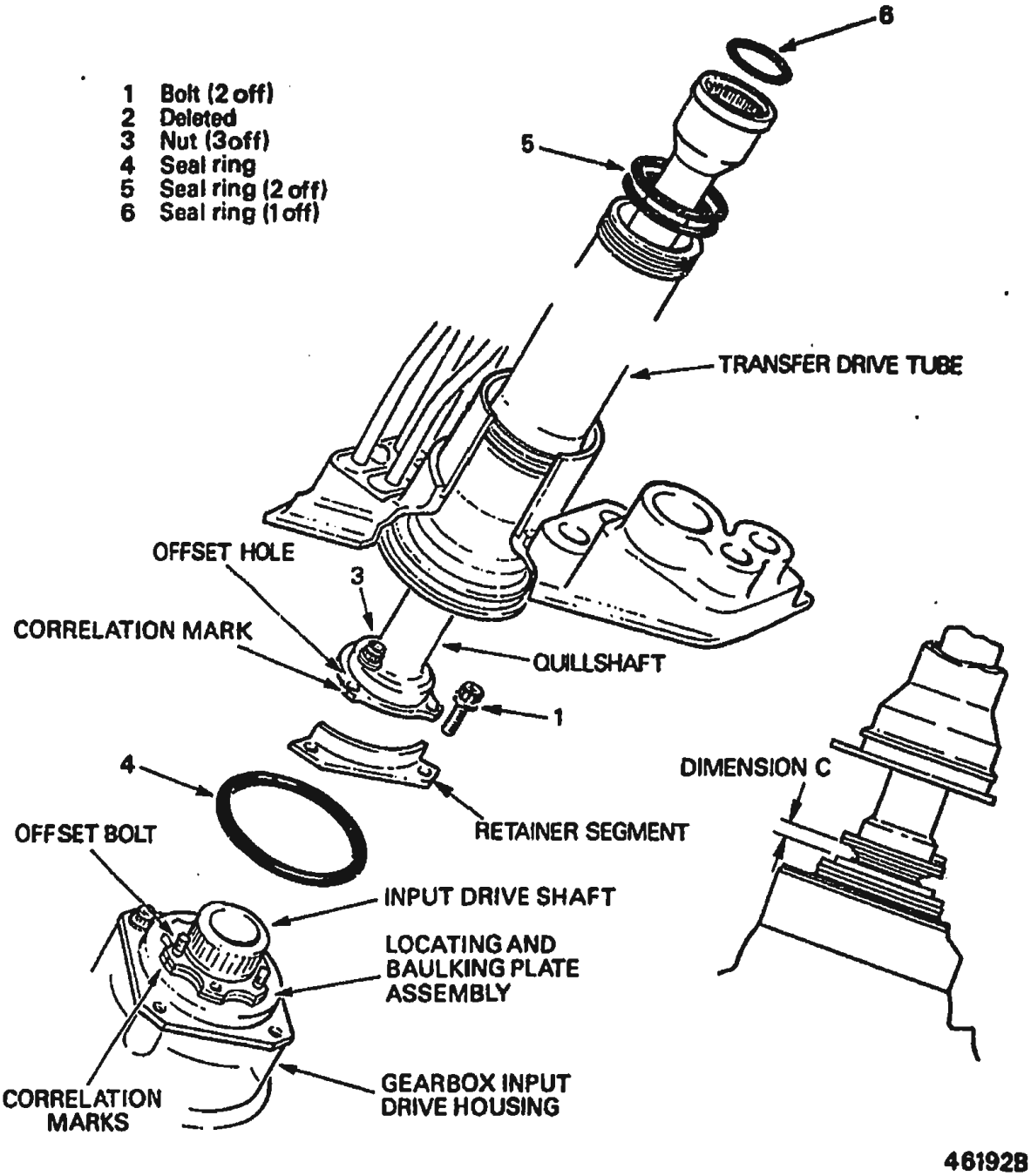
R (4) On engines with S.B.72-2946 and S.B.72-3158 mark quillshaft and locating plate with temporary correlation marks.

R (5) Engine without - S.B.72-3158 and 72-7443 remove 'D' headed bolts (2) and nuts (3) securing quillshaft locating plate.

R (6) Engines with S.B.72-2946, 72-3158 or 72-7443 remove nuts (3) securing quillshaft.

R (7) Push quillshaft in towards centre of engine as far as possible.

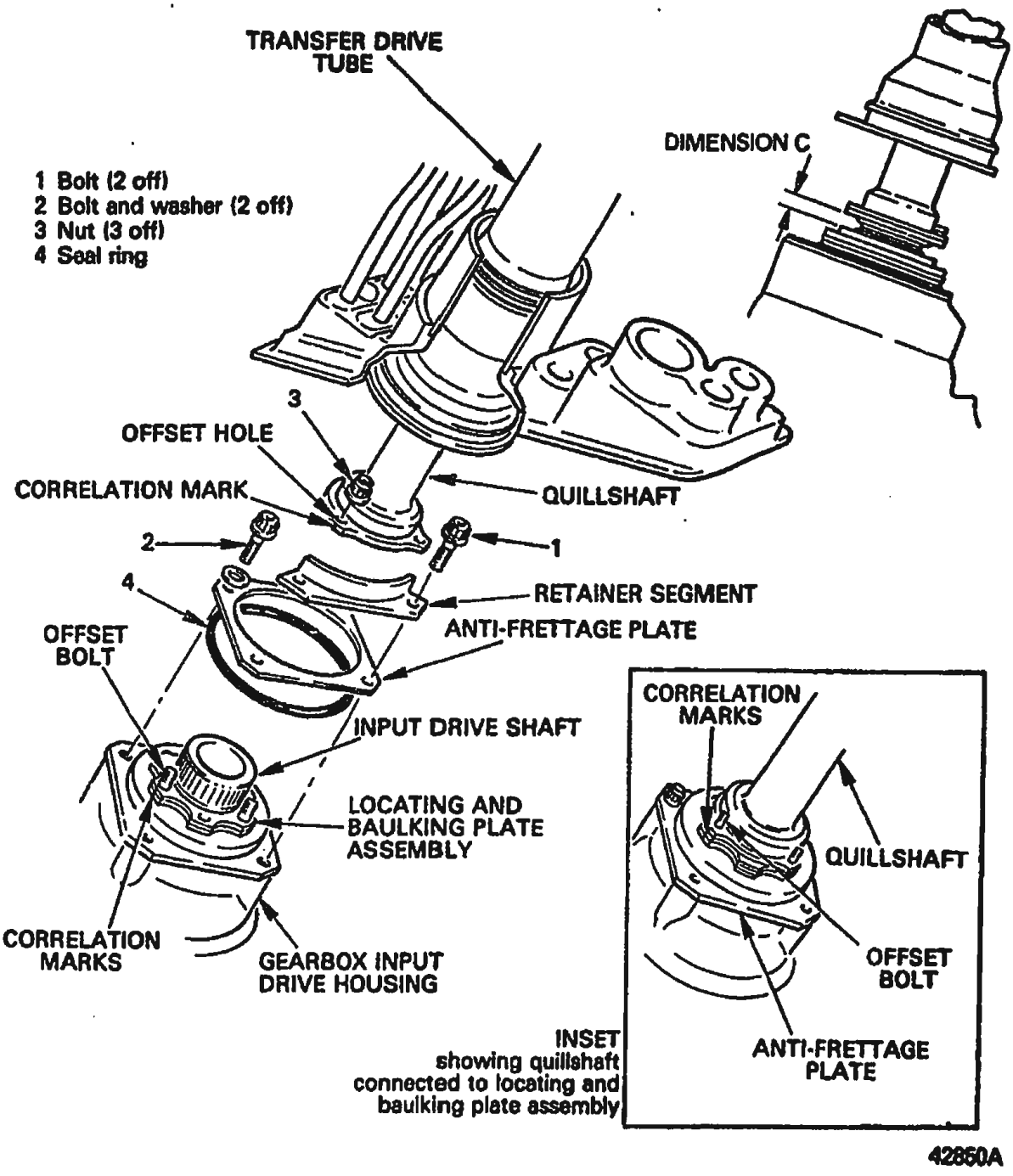
1 Bolt (2 off)
2 Deleted
3 Nut (3 off)
4 Seal ring
5 Seal ring (2 off)
6 Seal ring (1 off)



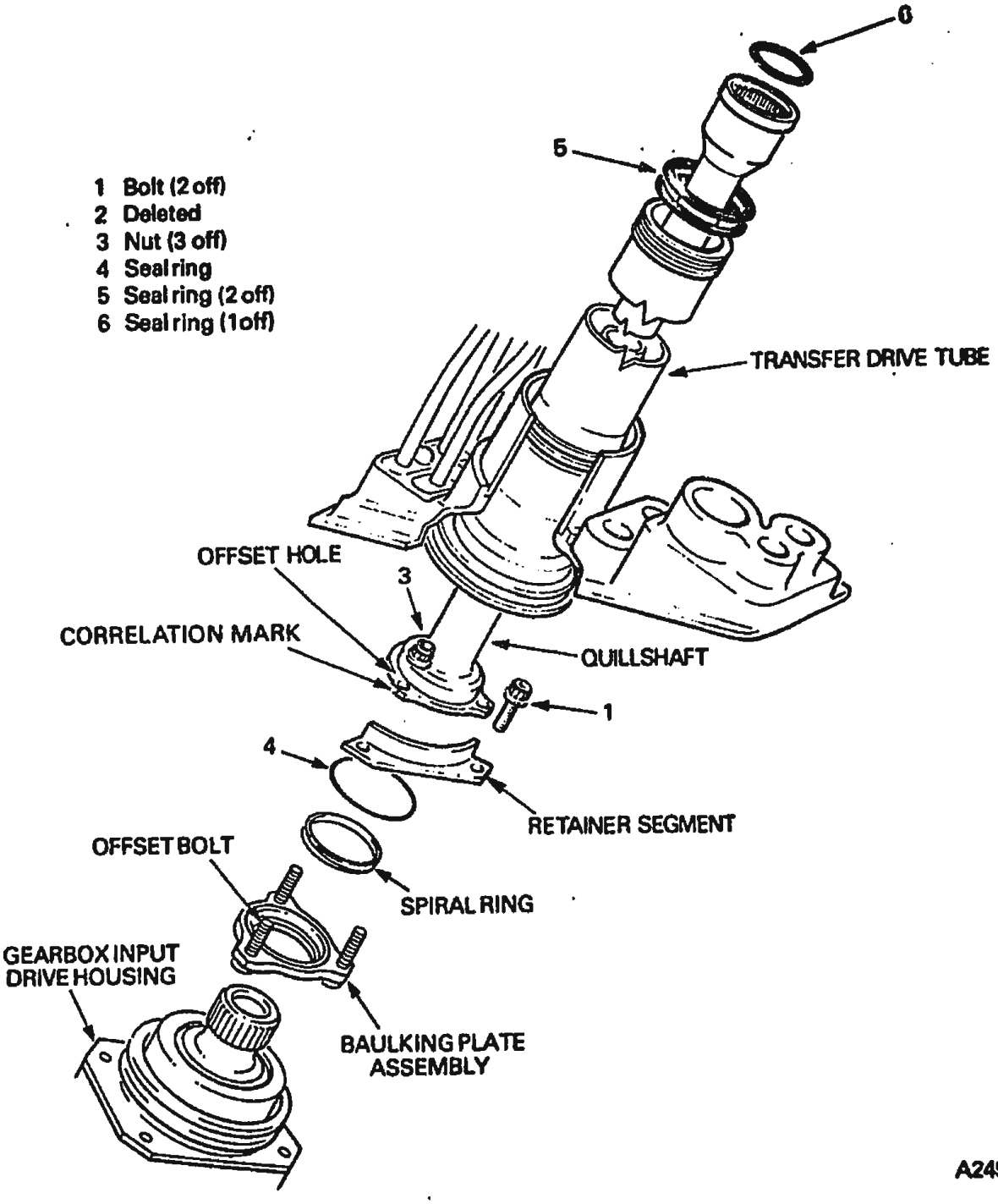

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R S.B.72-2946: Disconnect/Connect transfer drive
R tube and quillshaft
R Fig.402 (Sheet 1)

EFFECTIVITY: ALL




R S.B.72-3158: Disconnect/Connect transfer drive
R tube and quillshaft
R Fig.402 (Sheet 2)




R S.B.72-7443: Disconnect/Connect transfer drive
R tube and quillshaft
R Fig.402 (Sheet 3)

E. Remove fuel flow regulator F.T.C.S. box and linkage, and H.P. compressor bleed valve control unit.

(1) Remove F.T.C.S. box (Ref. 76-11-02) and B.V. control unit (Ref. 75-32-01).

F. Remove input drive housing, Fig.403

(1) Remove bolts and nuts at positions A securing L.T. harness support brackets.

(2) Remove bolts and nuts at position B securing fire detection harness support bracket.

(3) Remove bolts and nuts at position D securing B.V. solenoid support bracket.

(4) Remove bolts, washers and nuts at positions C.

(5) Remove input drive housing, freeing input drive housing to gearbox housing connector with spanner.

(6) Remove small oil connector with claw extractor, and remove filter from drive housing.

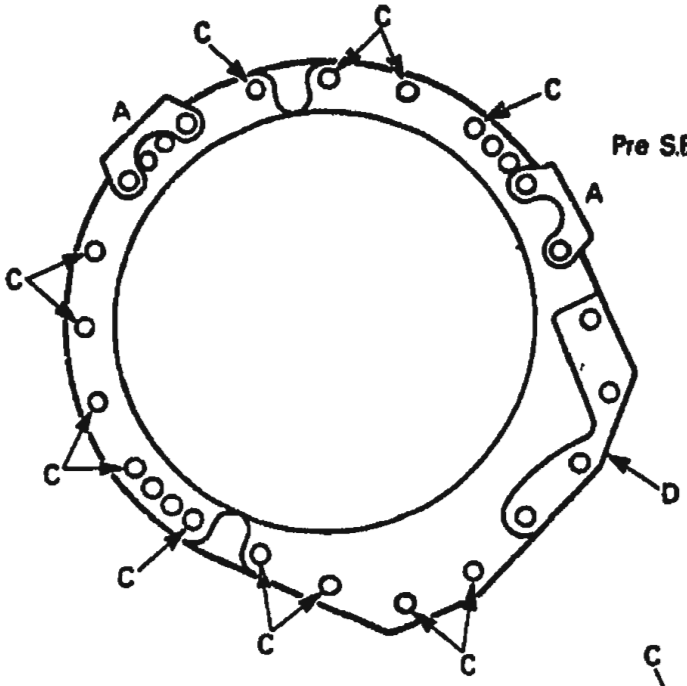
G. Remove tube numbers (1) to (7) and disconnect tube (8), Fig.404

(1) Disconnect and remove tubes (3).

(2) Refer to Fig.404 (Sheet 2) disconnect and remove tube (4) using tool UT.893 at H.P. fuel filter, and tool UT.894 at Service Disconnect Platform.

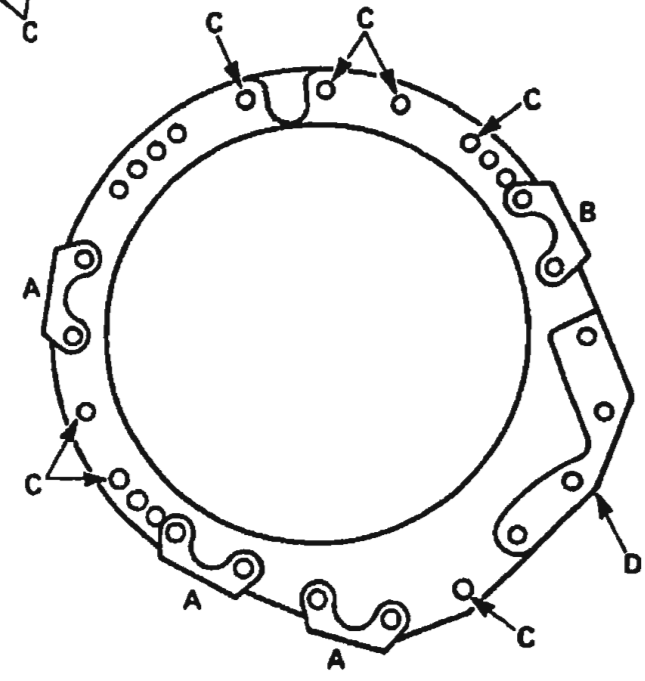
(3) Remove bolts and washers securing clamps on tubes (1) and (2) at services disconnect platform.

(4) Disconnect and remove tubes (1) and (2).




Pre S.B. 72-5250

A. L.T. harness support bracket
B. Fire detection harness support bracket
C. Bolt, washer and nut
D. H.P.3 bleed valve solenoid support bracket




S.B. 72-5250

44911

Remove/Install input drive housing
Fig.403

(5) Remove bolt and washer securing clamp on tube (5) at services disconnect platform.

(6) Disconnect and remove tube (5).

(7) Disconnect and remove tube (6).

(8) Disconnect and remove tube (7).

(9) Remove bolts and bracket securing tube (8) at drive housing.

H. Remove oil vent tube, Fig.405

(1) Disconnect and remove oil vent tube.

J. Pull transfer drive tube and quillshaft radially outward to clear bevel box.

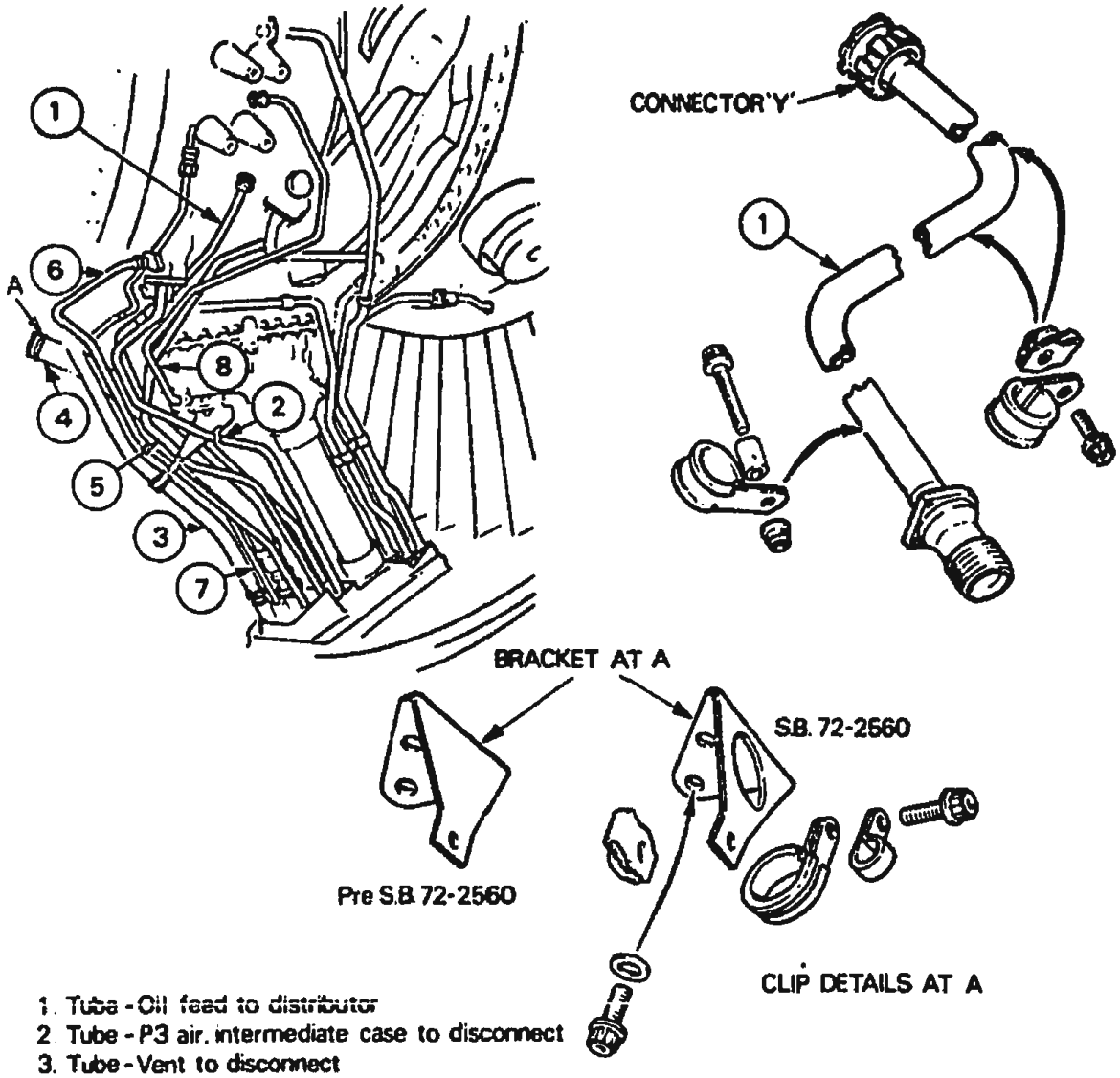
K. Remove bevel box, Fig.406

(1) On engines with S.B.72-4402, remove three bolts securing bevel box to intermediate case brackets.

(2) Remove ten bolts (4) and washers/spacers (3) securing bevel box to intermediate case.

(3) Remove bevel box complete with quillshaft; rotate bevel box during removal to avoid contact with transfer drive tube and quillshaft.

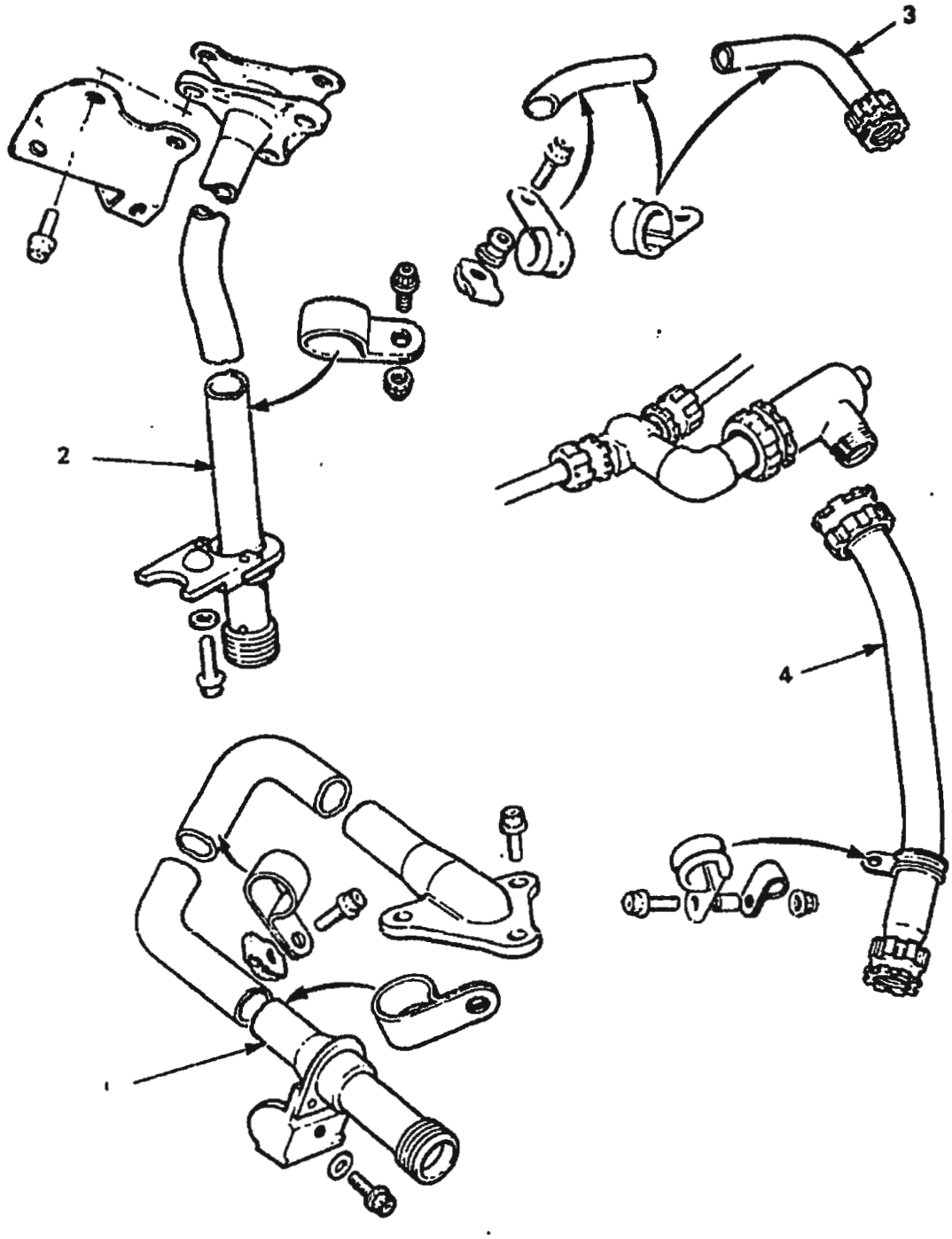
L. Fit blanks to all exposed connectors and apertures.



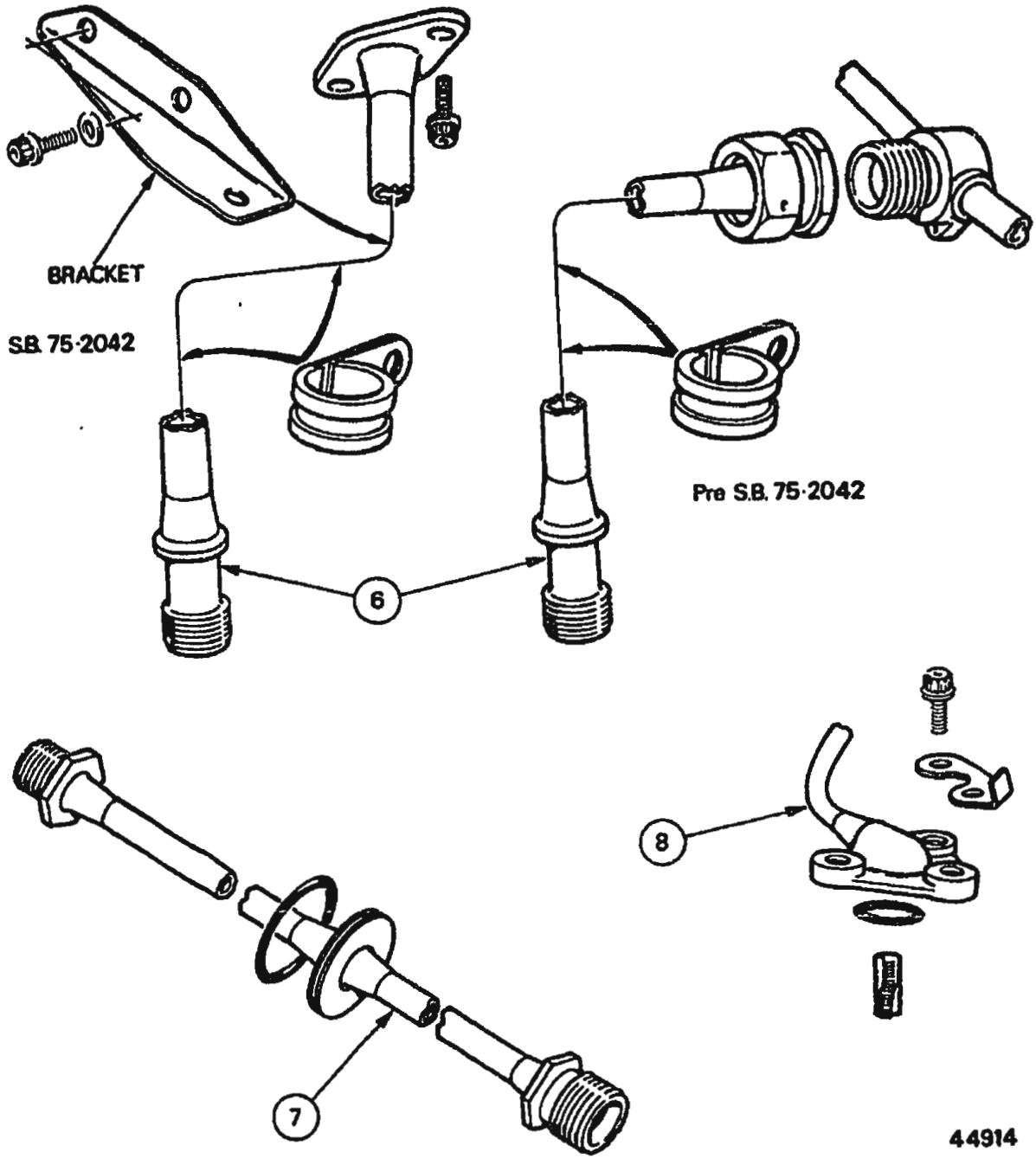

1. Tube - Oil feed to distributor
2. Tube - P3 air, intermediate case to disconnect
3. Tube - Vent to disconnect
4. Tube - Fuel feed to main manifolds
5. Tube - P3 air, intermediate case to disconnect
6. Tube - H.P.3 air, lower B.V. to disconnect
7. Tube - Fuel drain, fuel manifold
8. Tube - Oil feed, distributor to bevel box
9. Fuel manifolds

44912

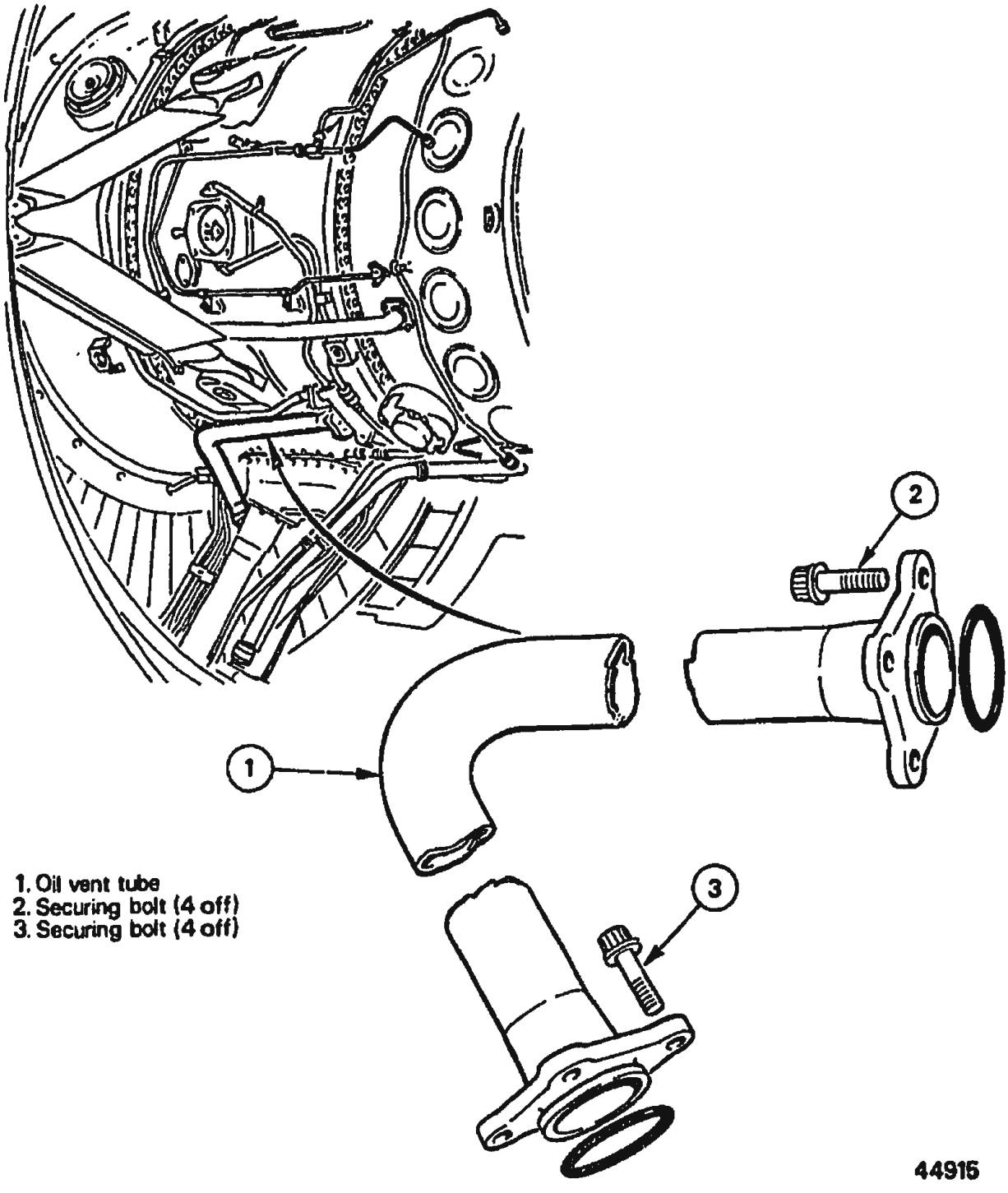
Remove/Install tubes 1 to 7 and disconnect 8
Fig.404 Sheet 1




Remove/Install tubes 1 to 7 and disconnect 8
Fig.404 Sheet 2

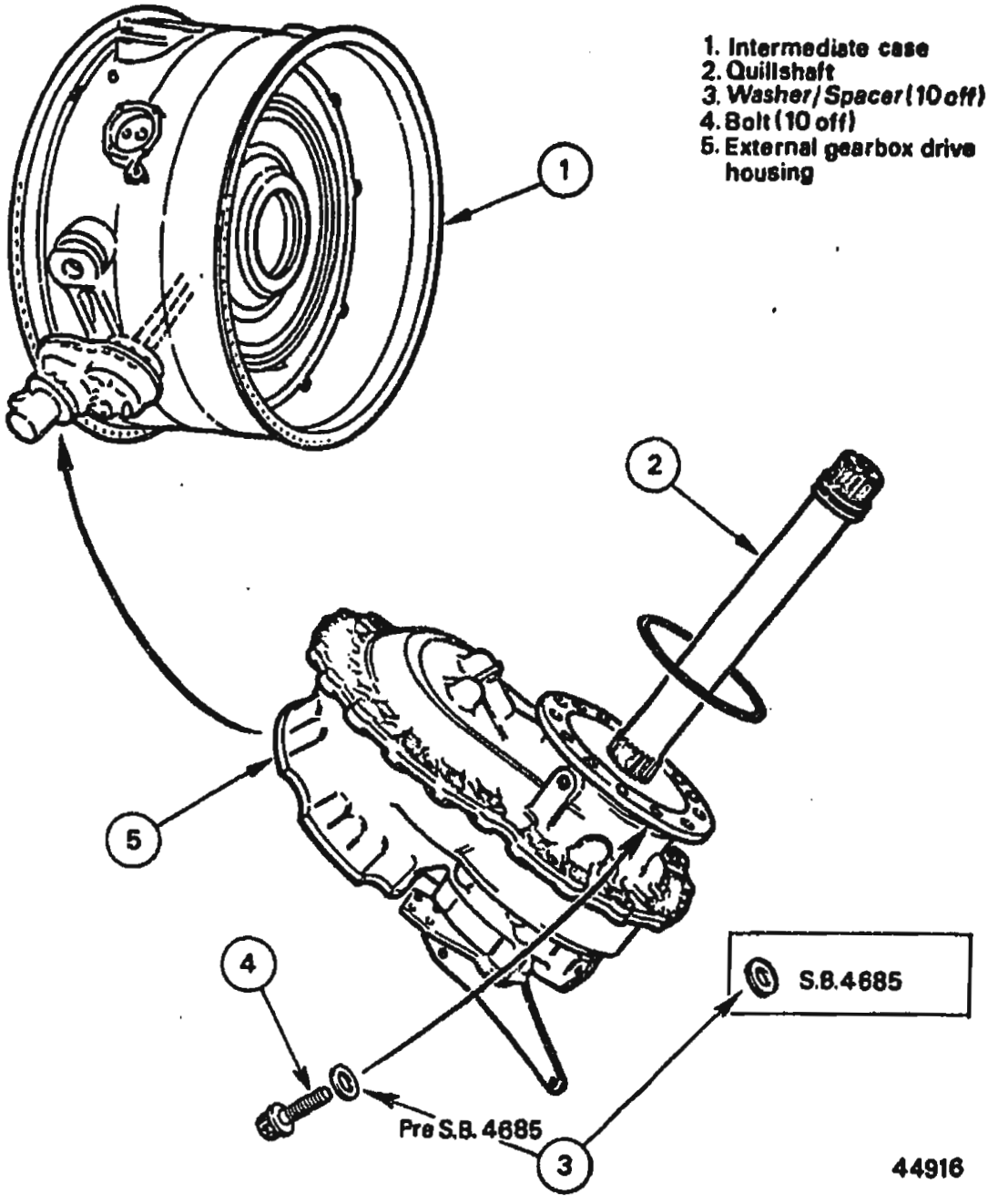



Remove/Install tubes 1 to 7 and disconnect 8
Fig.404 Sheet 3

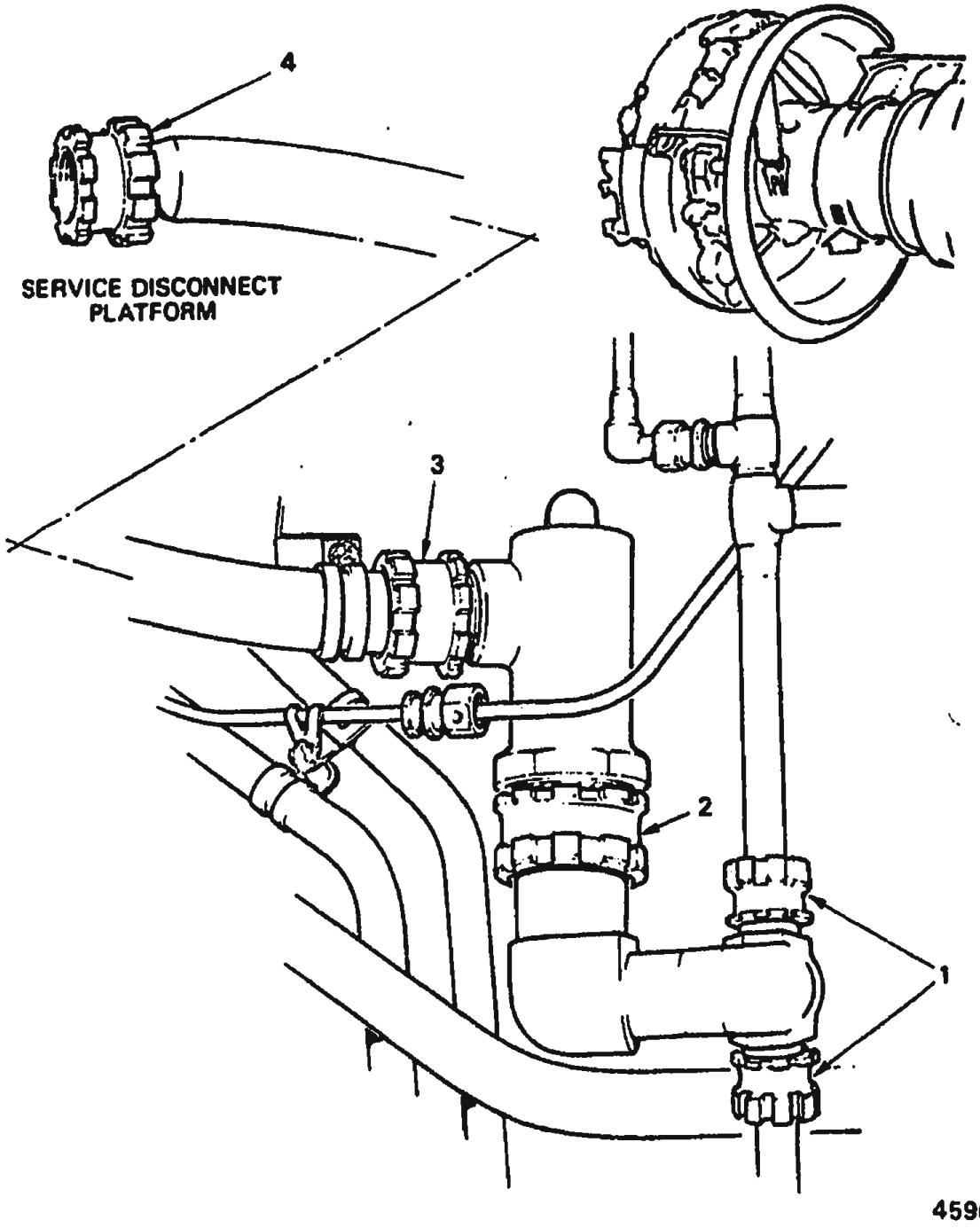



1. Oil vent tube
2. Securing bolt (4 off)
3. Securing bolt (4 off)

Remove/Install oil vent tube
Fig.405




Without S.B.72-2399 and with S.B.72-2399: Remove/Install external gearbox housing
Fig.406




Torque tightening procedure for main fuel supply tube
Fig.407

C 4. Install bevel box (Step aside gearbox)

A. Equipment required:

| | |
|---|---|
| UT630/1 | Fuel manifold connector spanner |
| UT893 | Spanner wrench |
| UT894 | Spanner wrench |
| 289200 or C4G4342 | Work mats |
| XUT30827 or HU20606 | Transfer tube alignment wrench |

B. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Jointing compound | DTD/4586 Hylomar PL32L | - | 4/46 |
| Loctite | IS495 | - | 8/159 |
| Approved clean engine oil | | | |

C. Fit bevel box, Fig.406

(1) Without S.B.72-2399: Apply jointing compound to mating faces of intermediate case and bevel box.

(2) S.B.72-2399: Lubricate and fit new sealing ring to mounting face groove in intermediate case.

CAUTION: TO AVOID LOSS OF BOLT TORQUE, ENSURE THAT CORRECT COMBINATION OF ATTACHING BOLTS, WASHERS/SPACERS TO THE APPROPRIATE SERVICE BULLETIN STANDARD (S.B.4685 OR 72-5127) IS USED.

R

(3) Ensure quillshaft is fitted to bevel box.

(4) Position bevel box on intermediate case and secure with the appropriate Service Bulletin standard of attaching parts as follows:

(a) Without S.B.72-4685; washer (3) 10 off and bolts (4) 10 off.

(b) S.B.72-4685; spacer (3) 10 off and bolts (4) 10 off.

(c) S.B.72-5127; washer (3) 10 off and bolts (4) 10 off.

D. Fit transfer drive tube and quillshaft, Fig.402, (Sheet 1, 2 or 3).

(1) Lubricate and fit new sealing rings to inner (engine) end of transfer drive tube.

(2) Lubricate and fit new sealing rings to inner (engine) end of quillshaft.

(3) Fit transfer drive tube and quillshaft to bevel box and push fully home.

E. Fit oil vent tube, Fig.405

(1) Lubricate and fit new sealing rings to oil vent tube.

(2) Fit oil vent tube and secure with eight bolts.

F. Fit tubes (1) to (7) and connect tube (8), Fig.404

(1) Lubricate and fit new sealing rings to tube (8).

(2) Ensure thread filter is fitted; fit bracket and bolts to secure tube (8).

(3) Lubricate and fit new sealing rings to tube (7).

(4) Fit and secure tube (7).

(5) Wirelock tube (7) end connectors.

(6) Without S.B.75-2042 and S.B.75-2042: fit and secure tube (6).

(7) Fit and secure tube (1).

(8) Torque tighten tube (1) inner end connector Y to 630 lb.in.

(9) Fit and secure tubes (2) and (5).

(10) Fit bolts and washers securing clamps on tubes (2) and (5) at services disconnect platform.

(11) Fit tube (4) refer to Fif.407

(a) Lightly lubricate connector threads and sealing surface with engine oil.

(b) Position tube (4) at Services Disconnect Platform and H.P. fuel filter.

(c) Slacken connectors (1) (using tool UT.630/1) and (2) (using tool UT.894).

(d) Finger tighten connectors (1) to (4) in sequence to align parts.

(e) Torque tighten connectors (1) to 250 lb.in. (28.2 Nm.).

(f) Release connectors (1).

(g) Repeat operations (e) and (f) twice more.

(h) Finally torque tighten connecors (1) to 500 lb.in. (56.5 Nm.).

R (j) Torque tighten the connectors (2), (3) and (4)
R in sequence (Ref.70-51-00). Using tool UT.893,
R torque tighten connector (3) to 1020 lb.in.
R (115,2 Nm). Using tool UT.894, torque tighten
R connector (4) to the standard load and torque
R tighten connector (2) to 1440 lb.in.(162,7 Nm).
R Wirelock the connectors (2), (3) and (4).

(12) Fit and secure tube (3).

(13) Wirelock tube (3) end connectors.

G. Fit input drive housing, Fig.403

NOTE: A complete bevel gears - input drive housing assembly can be replaced if:

the replacement assembly has been assembled in accordance with the engine manual Ref.E.M.72-61-50, Sub-assembly

OR

the replacement assembly has been removed from a serviceable high speed external gearbox (06 Module) and that it is of a compatible modification standard REF.M.M.70-01-07, Module Identification and Interchangeability.

(1) Fit thread filter to drive housing.

(2) Lubricate and fit new seal rings to input drive housing small oil connector.

(3) Fit small oil feed connector to drive housing.

(4) Lubricate and fit new seal rings to input drive housing large connector.

(5) Fit large connector to drive housing.

(6) S.B.72-4547: Lubricate and fit new sealing ring to joint face of drive housing.

(7) Fit drive housing to external gearbox ensuring that both connectors are correctly located.

(8) Fit bolts and washers at positions C and finger tighten.

(9) Fit B.V. control unit and brackets (75-32-01).

(10) Fit F.T.C.S. box (76-11-02).

(11) Fit L.T. harness support brackets at positions A and finger tighten bolts.

(12) Fully tighten all twenty one bolts.

H. Check input drive gear backlash

(1) Check that backlash exists on the input drive driving gear.

J. Connect quillshaft and transfer drive tube

NOTE: S.B.72-2946 refer to fig.402 (Sheet 1)
S.B.72-3158 refer to fig.402 (Sheet 2)
S.B.72-7443 refer to fig.402 (Sheet 3)

(1) On engines without S.B.72-7443 lubricate and fit new seal ring (4) to input drive housing.

(2) Inspect quillshaft and locating plate mating faces for burrs and high spots. Remove by stone/hand polish (Ref.70-42-11 FRS.3253).

(3) On engines with S.B.72-7443 bond the new seal ring into the baulking plate flange groove with Loctite IS495.

(4) CAUTION: ENSURE CORRECT LOCATION OF SHAFT SPLINES BY CHECKING THAT THE INPUT DRIVE SHAFT SPLINES ARE FULLY ENGAGED IN QUILLSHAFT AND ARE NOT VISIBLE BETWEEN QUILLSHAFT AND LOCATING PLATE. DO NOT USE LOCATING PLATE BOLTS AND NUTS TO FORCE QUILLSHAFT INTO FULL ENGAGEMENT.

Pull quillshaft radially outwards to engage splines on input drive shaft.

(5) On engines with S.B.72-2946 or S.B.72-3158 align correlation marks.

(6) Engines without S.B.72-3158 or S.B.72-7443 fit and secure locating plate with 'D' headed bolts and nuts (3) and (4).

(7) Engines with S.B.72-2946 or S.B.72-3158 or S.B.72-7443 fit nuts (3) and secure quillshaft.

(8) Engines without S.B.72-7443 measure dimension 'C' (Ref Fig.402 Sheet 1 or Fig.402 Sheet 2) and ensure that dimension does not exceed 0.649ins. (16,5 mm.). Without S.B.72-3158 or 0.224ins. (5,7 mm.) S.B.72-3158.

(9) Engines with S.B.72-2946 or S.B.72-3158 or S.B.72-7443 pull transfer drive tube radially outwards and position on input drive housing then position retainer segment and secure with bolts (1).

K. Connect tubes (1) and (2) at disconnect platform, Fig.401

(1) Connect tubes (1) and (2).

(2) Torque tighten end connectors to standard loading.

(3) Wirelock end connectors.

L. Fit compressor section fairings

(1) Fit compressor section fairings (Ref. 72-03-00).

(2) Remove work mats.

M. Perform Test No.5.

R # HIGH SPEED EXTERNAL GEARBOX TRANSFER DRIVE TUBE -
R # REMOVAL/INSTALLATION

R 1. General

R For standard torque loadings and torque tightening technique, refer to 70-51-00.

R Special torque loadings and assembly tolerances are detailed at the appropriate stage in the procedure.

R Discard all rubber seal rings, cotter pins and key washers during removal sequence.

R For identification, lubrication and fitting of rubber sealing rings, refer to 70-02-01.

R 2. Removal/Installation High Speed External Gearbox Transfer Drive Tube

R WARNING: THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE MAY CAUSE IRRITATION IF SKIN CONTACT IS REPEATED OR PROLONGED.

R CAUTION: 1. THE OIL SPECIFIED FOR USE IN THIS ENGINE IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS NOT NORMALLY IN CONTACT WITH OIL. SPILT OIL MUST BE WIPED AWAY IMMEDIATELY.

R 2. ENSURE ELECTRICAL CONNECTORS ARE FREE FROM LIQUID AND/OR SOLID CONTAMINATION BEFORE CONNECTING OR DISCONNECTING. FAILURE TO DO SO CAN RESULT IN A FIRE.

R Service Bulletins referred to:

R 72-2435 - H.S. gearbox drive shaft outer tube with location check markings
R 72-2946 - Transfer drive tube with quadrant clamp retainer
R 72-3158 - Improved retention and lubrication of drive quillshaft
R 72-4547 - External gearbox - Improved sealing between drive housing and external gearbox
R 72-7443 - Improved spline lubrication and shaft retention with spiral ring weir

R Referenced Procedures:

R 70-51-00 Torque Tightening Techniques
R 70-02-01 Identification, Lubrication and Fitting of Rubber
R Sealing Rings
R 71-00-00 Power Plant - Adjustment/Test
R 72-03-00 Gas Generator Fairings - Removal/Installation

## R 3. Prepare to Remove External Gearbox Transfer Drive Tube

R A. Equipment required:

| | |
|---|---|
| R HU19863 | Claw extractor |
| R HU20606 | 'C' Wrench spanner |

R B. Remove compressor section fairings

R (1) Remove compressor section rear left-hand and
R right-hand fairings (Ref. 72-03-00).

R (2) Remove compressor section lower left-hand and
R right-hand fairings (Ref. 72-03-00).

R C. Disconnect tubes (1) and (2), fig.401

R NOTE: This operation is necessary to allow the transfer
R drive tube to be disconnected.

R D. Disconnect transfer drive tube and quillshaft

R NOTE: S.B.72-2946 refer to fig.402 (Sheet 1).
R S.B.72-3158 refer to fig.402 (Sheet 2).
R S.B.72-7443 refer to fig.402 (Sheet 3).

R (1) Engines with S.B.72-2946 remove bolts (1) securing
R tube retainer segment.

R (2) Break stick of seals using 'C' wrench.

R (3) Push transfer drive tube in towards centre of engine
R to expose quillshaft locating plate and securing
R details. Remove and discard seal ring (4). Care must
R be exercised not to damage the seal carrier section of
R the input drive bevel gear assembly.

R (4) On engines with S.B.72-2946 and S.B.72-3158 mark
R quillshaft and locating plate with temporary correlation
R marks.

R (5) Engines with 72-2946 or 72-3158 or 72-7443 remove
R nuts (3) securing quillshaft.

R (6) Push quillshaft in towards centre of engine as far
R as possible.

R E. Remove fuel flow regulator F.T.C.S. box and linkage, and
R H.P. compressor bleed valve control unit.

R (1) Remove F.T.C.S. box (Ref. 76-11-02) and bleed valve
R control unit (Ref. 75-32-01).

R F. Remove input drive housing, Fig.403

R (1) Remove bolts and nuts at positions A securing L.T.
R harness support brackets.

R (2) Remove bolts and nuts at position B securing fire
R detection harness support bracket.

R (3) Remove bolts and nuts at position D securing bleed
R valve solenoid support bracket.

R (4) Remove bolts, washers and nuts at positions C.

R (5) Remove input drive housing, freeing input drive
R housing to gearbox housing connector with spanner.

R (6) Remove small oil connector with claw extractor, and
R remove filter from drive housing.

R G. Remove transfer drive tube and quillshaft, Fig.402

R (1) Pull transfer drive tube and quillshaft radially outward
R to remove them from engine.

R (2) Remove and discard seal rings (5) and (6).

R H. Fit blanks to all exposed connectors and apertures.

R 4. Install External Gearbox Transfer Drive Tube

R A. Equipment required:

| | | |
|---|---|---|
| R | 289200 or C4G4342 | Work mats |
| R | XUT30827 or HU20606 | Transfer tube alignment wrench |

R B. Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| R Loctite | IS495 | - | 8/159 |
| R Approved clean engine oil | | | |

R C. Fit transfer drive tube and quillshaft, Fig.402,(Sheets 1, 2 R and 3).

R (1) Lubricate and fit new sealing rings (5) to inner R (engine) end of transfer drive tube.

R (2) Lubricate and fit new sealing ring (6) to inner (engine) R end of quillshaft.

R (3) Engage splines of quillshaft with driven bevel gearshaft R and push fully home. Locate transfer drive tube in R gearbox drive housing and push fully home.

R D. Fit input drive housing, Fig.403

R NOTE: A complete bevel gears - input drive housing assembly R can be replaced if:

R (a) the replacement assembly has been assembled in R accordance with the engine manual Ref. E.M.72-61-50, R Sub-assembly

R or

R (b) the replacement assembly has been removed from a R serviceable high speed external gearbox (06 Module) R and that it is of a compatible modification standard R Ref. M.M.70-01-07, Module Identification and R Interchangeability.

R (1) Fit thread filter to drive housing.

R (2) Lubricate and fit new seal rings to input drive
R housing small oil connector.

R (3) Fit small oil feed connector to drive housing.

R (4) Lubricate and fit new seal rings to input drive
R housing large connector.

R (5) Fit large connector to drive housing.

R (6) S.B.72-4547: Lubricate and fit new sealing ring to
R joint face of drive housing.

R (7) Fit drive housing to external gearbox ensuring that
R both connectors are correctly located.

R (8) Fit bolts and washers at positions C and finger
R tighten.

R (9) Fit Bleed valve control unit and brackets (75-32-01).

R (10) Fit F.T.C.S. box (76-11-02).

R (11) Fit L.T. harness support brackets at positions A
R and finger tighten bolts.

R (12) Fully tighten all twenty one bolts.

R E. Check input drive gear backlash

R (1) Check that backlash exists on the input drive driving
R gear.

R F. Connect quillshaft and transfer drive tube

R NOTE: S.B.72-2946 refer to fig.402 (Sheet 1).
R S.B.72-3158 refer to fig.402 (Sheet 2).
R S.B.72-7443 refer to fig.402 (Sheet 3).

R (1) On engines without S.B.72-7443 lubricate and fit new
R seal ring (4) to input drive housing.

R (2) Inspect quillshaft and locating plate mating faces for
R burrs and high spots. Remove by stone/hand polish
R (Ref.70-42-11 FRS.3253).

R (3) On engines with S.B.72-7443 bond the new seal ring into
R the baulking plate flange groove with Loctite IS495.

R (4) CAUTION: ENSURE CORRECT LOCATION OF SHAFT SPLINES BY
R CHECKING THAT THE INPUT DRIVE SHAFT SPLINES
R ARE FULLY ENGAGED IN QUILLSHAFT AND ARE NOT
R VISIBLE BETWEEN QUILLSHAFT AND LOCATING PLATE.
R DO NOT USE LOCATING PLATE BOLTS AND NUTS TO
R FORCE QUILLSHAFT INTO FULL ENGAGEMENT.
R Pull quillshaft radially outwards to engage splines on
R input drive.

R (5) On engines with 72-2946 or 72-3158 align correlation
R marks.

R (6) Engines with 72-2946 or 72-3158 or 72-7443 fit nuts (3)
R and secure quillshaft.

R (7) Engines without 72-7443 measure dimension 'C' (Ref.
R Fig.402 Sheet 1 or Fig.402 Sheet 2) and ensure that
R dimension does not exceed 0.649in. (16,5 mm.) without
R 72-3158 or 0.224in. (5,7 mm.) with 72-3158.

R (8) Engines with 72-2946 or 72-3158 or 72-7443 pull transfer
R drive tube radially outwards and position on input drive
R housing, then position retainer segment and secure with
R bolts (1).

R G. Connect tubes (1) and (2) at disconnect platform, Fig.401

R (1) Connect tubes (1) and (2).

R (2) Torque tighten end connectors to standard loading.

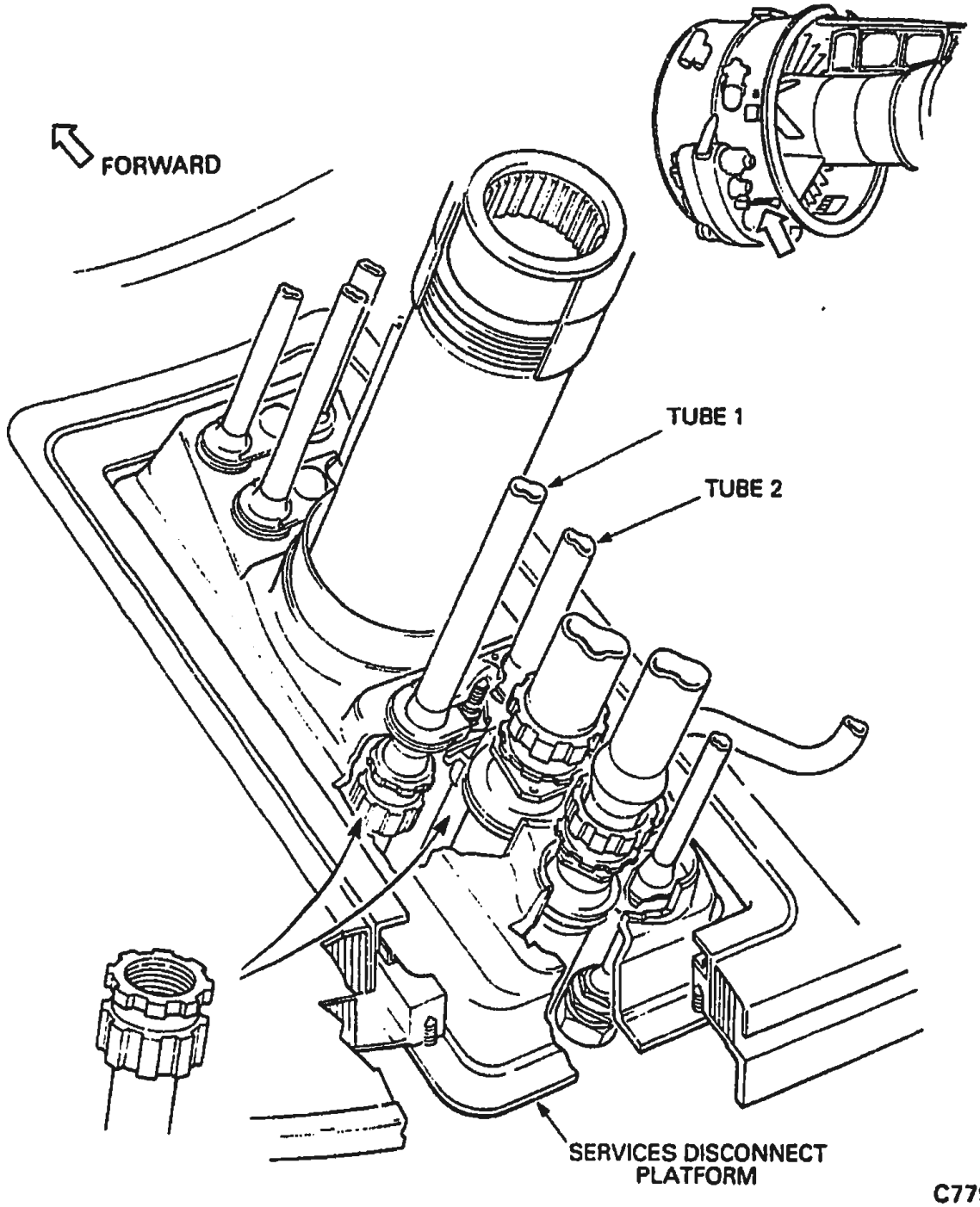
R (3) Wirelock end connectors.

R H. Fit compressor section fairings

R (1) Fit compressor section fairings (Ref. 72-03-00).

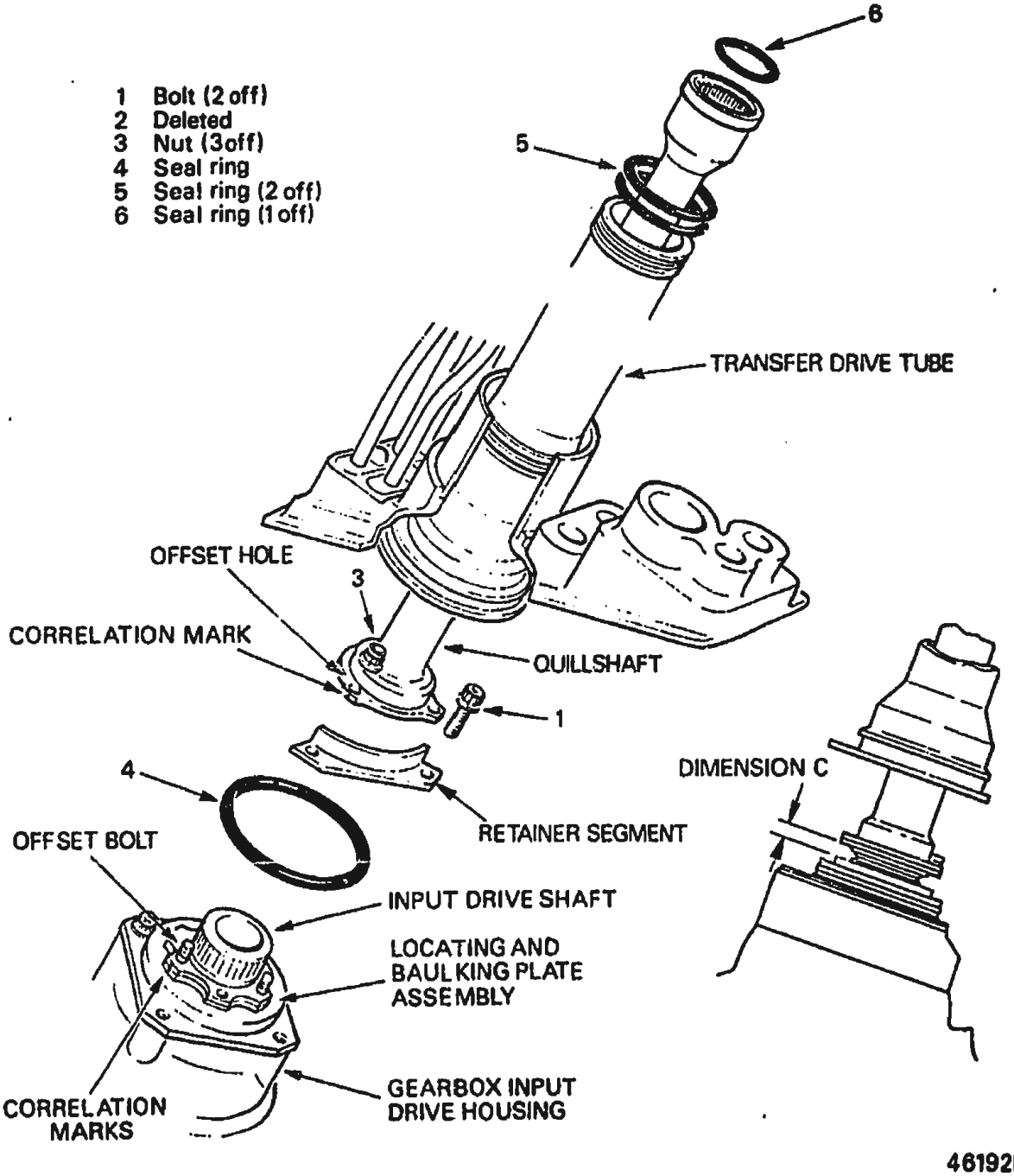
R (2) Remove work mats.

R J. Perform Test No.2 (Ref.71-00-00).



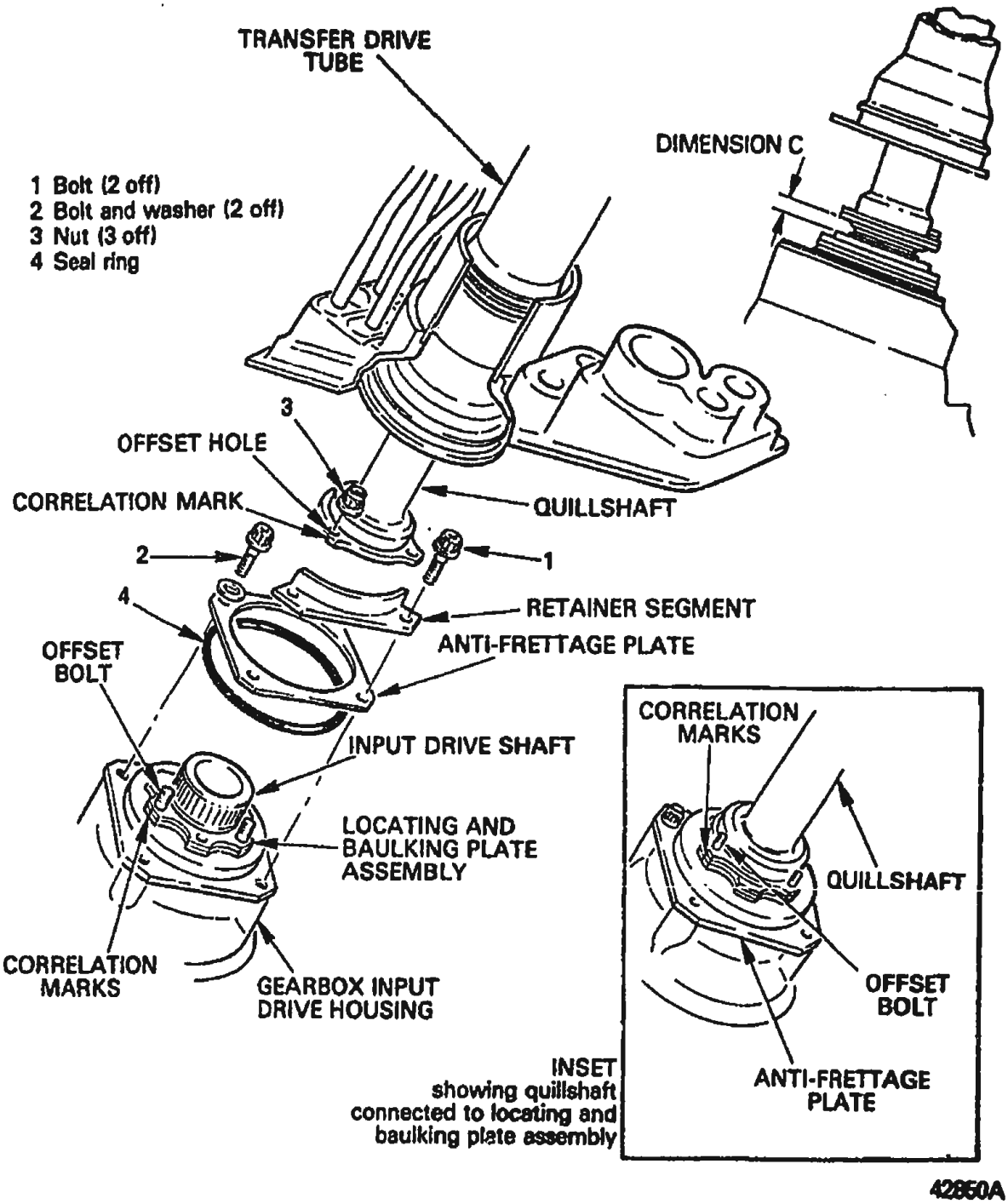

R Disconnect/Connect tubes at services disconnect platform
R Fig.401

1 Bolt (2 off)
2 Deleted
3 Nut (3off)
4 Seal ring
5 Seal ring (2 off)
6 Seal ring (1 off)

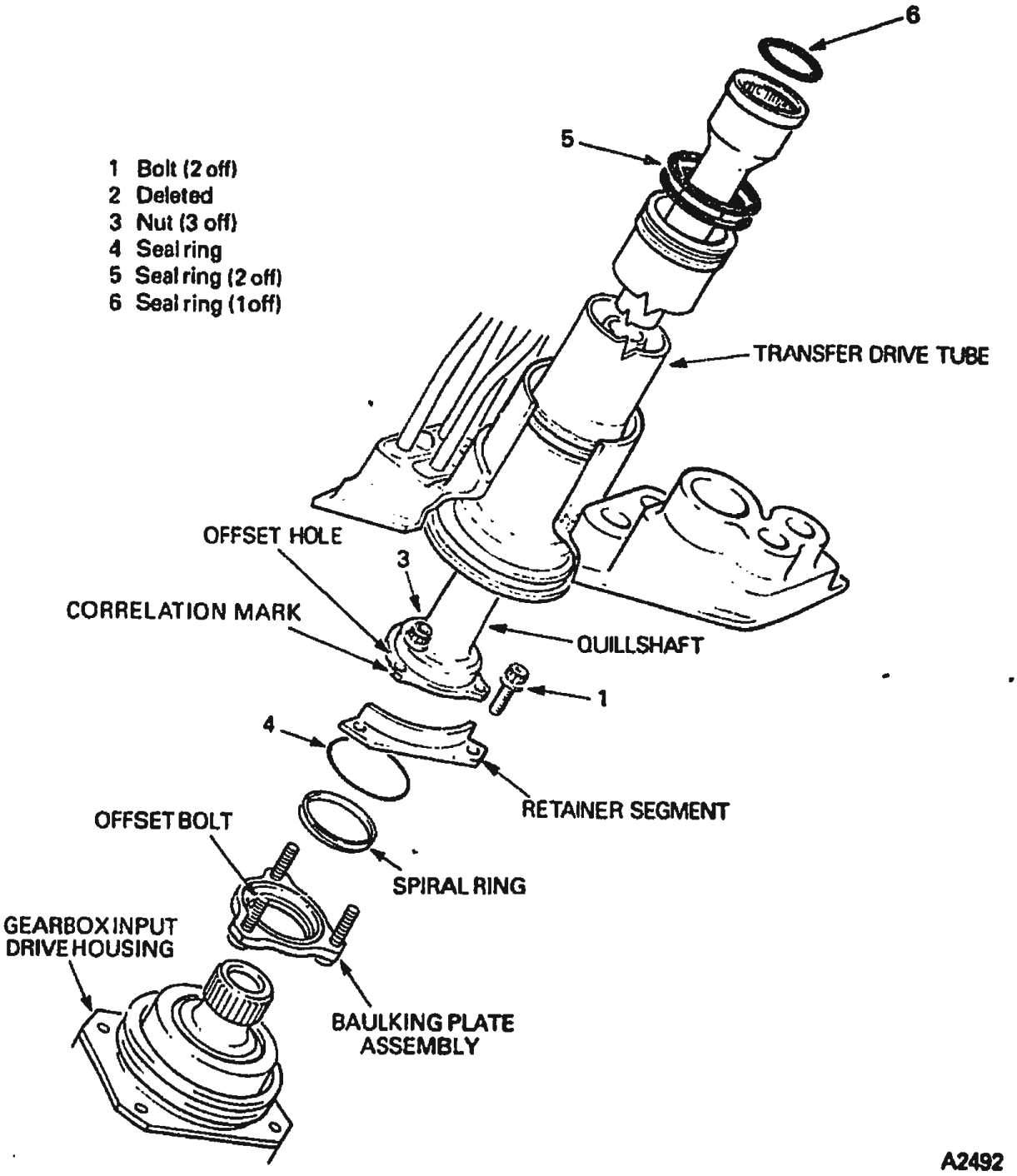



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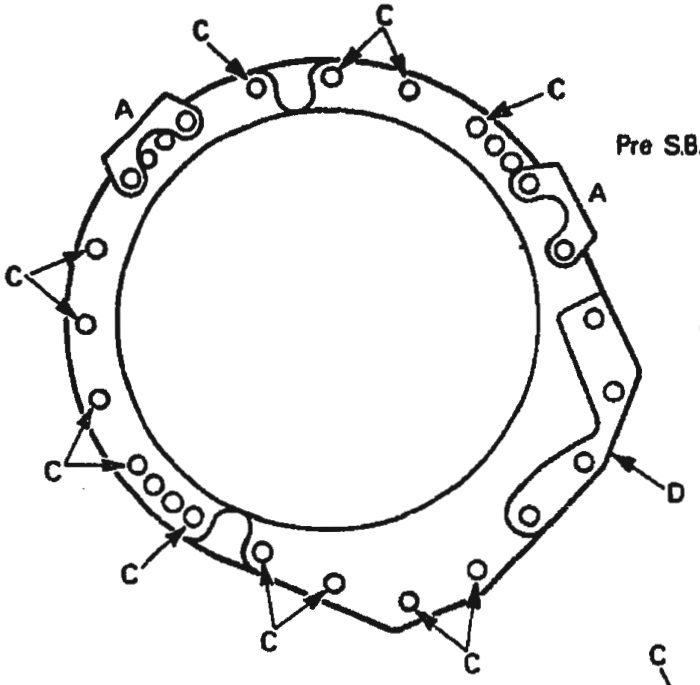
R S.B.72-2946: Disconnect/Connect transfer drive
R tube and quillshaft
R Fig.402 (Sheet 1)




R S.B.72-3158: Disconnect/Connect transfer drive
R tube and quillshaft
R Fig.402 (Sheet 2)

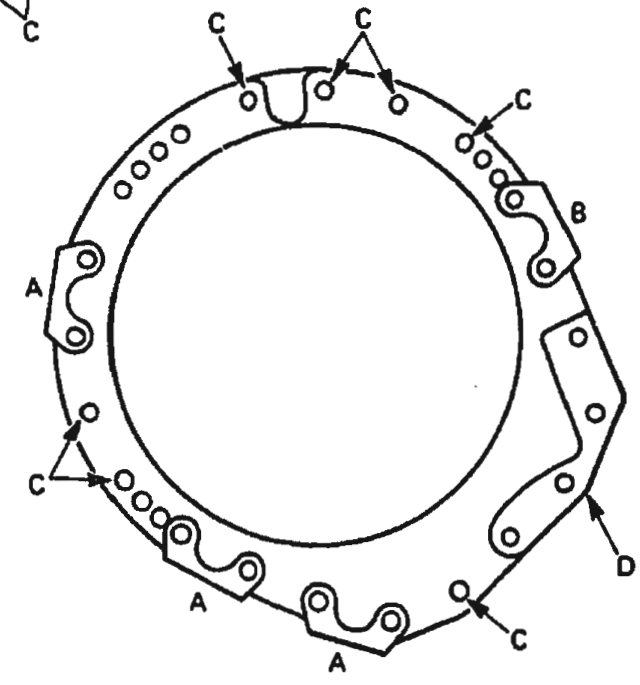



R S.B.72-7443: Disconnect/Connect transfer drive
R tube and quillshaft
R Fig.402 (Sheet 3)




Pre S.B. 72-5250

A. L.T. harness support bracket
B. Fire detection harness support bracket
C. Bolt, washer and nut
D. H.P.3 bleed valve solenoid support bracket




S.B. 72-5250

44911

R Remove/Install input drive housing
R Fig.403

R EFFECTIVITY: ALL
R
050B 1A

## R HIGH SPEED GEARBOX TRANSFER DRIVE TUBE - INSPECTION/CHECK

### R 1. General

R A. The bottom flange of the piston ring groove can be seen from below the engine, where the transfer drive tube passes through the services disconnect panel.

R B. If the piston ring itself is visible, this shows that the flange has been worn through.

### R 2. Inspect the Piston Ring Groove

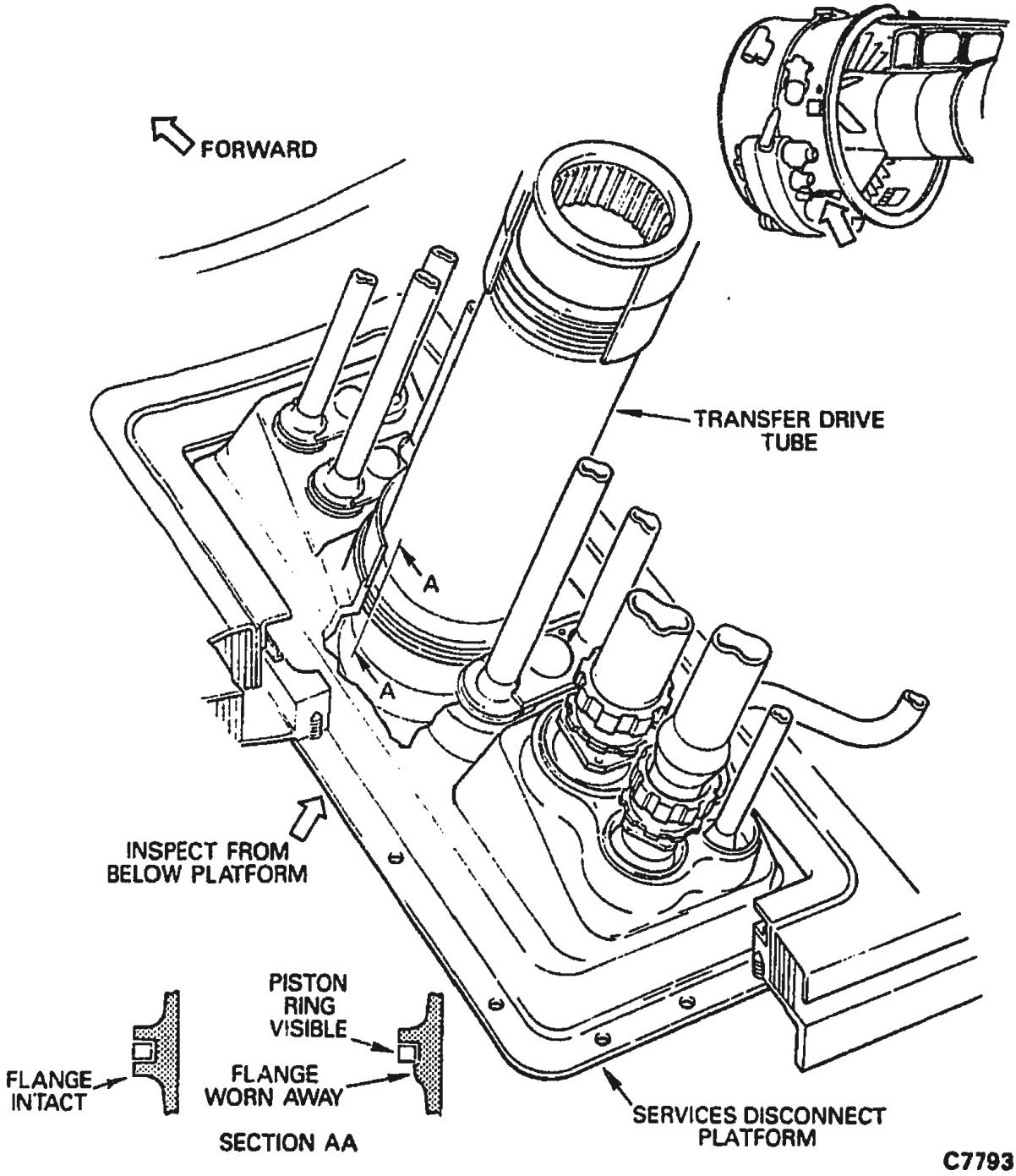
R A. Inspect the bottom flange of the piston ring groove for wear (Ref. Fig.601).

R For acceptance standards, see para.3.

### R 3. Acceptance Standards

R A. Up to half the circumference (180 deg.) of piston ring visible - Accept.

R B. More than half the circumference of piston ring visible - Reject.




R Transfer drive tube - Inspection/Check
R Fig.601

## HIGH-SPEED EXTERNAL GEARBOX - REMOVAL/INSTALLATION

R WARNING: THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE MAY
R CAUSE SKIN IRRITATION IF SKIN CONTACT IS REPEATED OR
R PROLONGED.

CAUTION:
1. THE OIL SPECIFIED FOR USE IN THIS OIL SYSTEM IS INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS OF THE ENGINE NOT NORMALLY IN CONTACT WITH IT. ANY OIL SPILT DURING SERVICING MUST BE WIPED UP IMMEDIATELY.

2. ENSURE ELECTRICAL CONNECTORS ARE FREE FROM LIQUID AND/OR SOLID CONTAMINATION BEFORE DISCONNECTING AND CONNECTING. FAILURE TO DO SO COULD RESULT IN A FIRE.

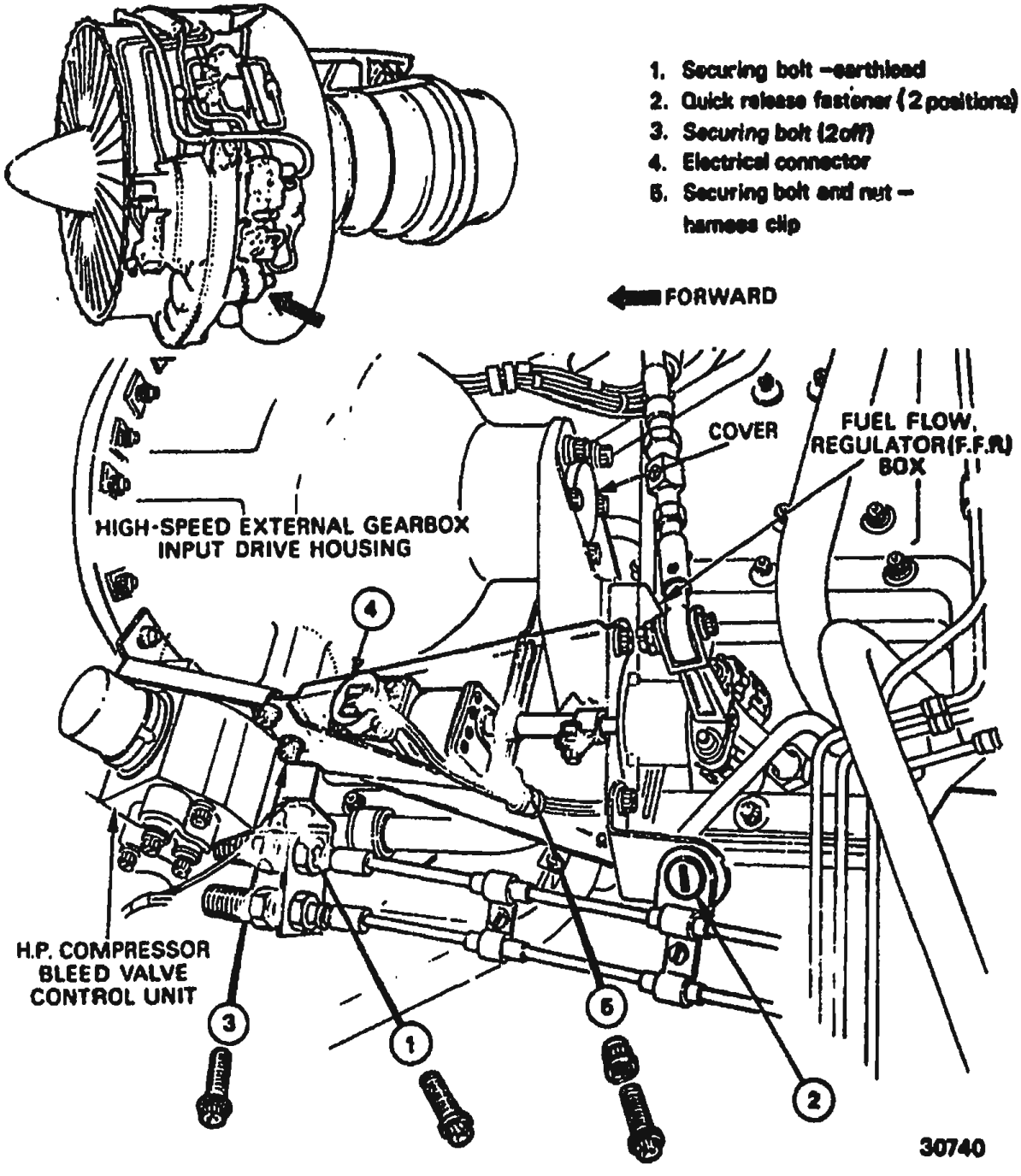
### 1. Removal/Installation Input Drive Oil Jet

Service Bulletins referred to:

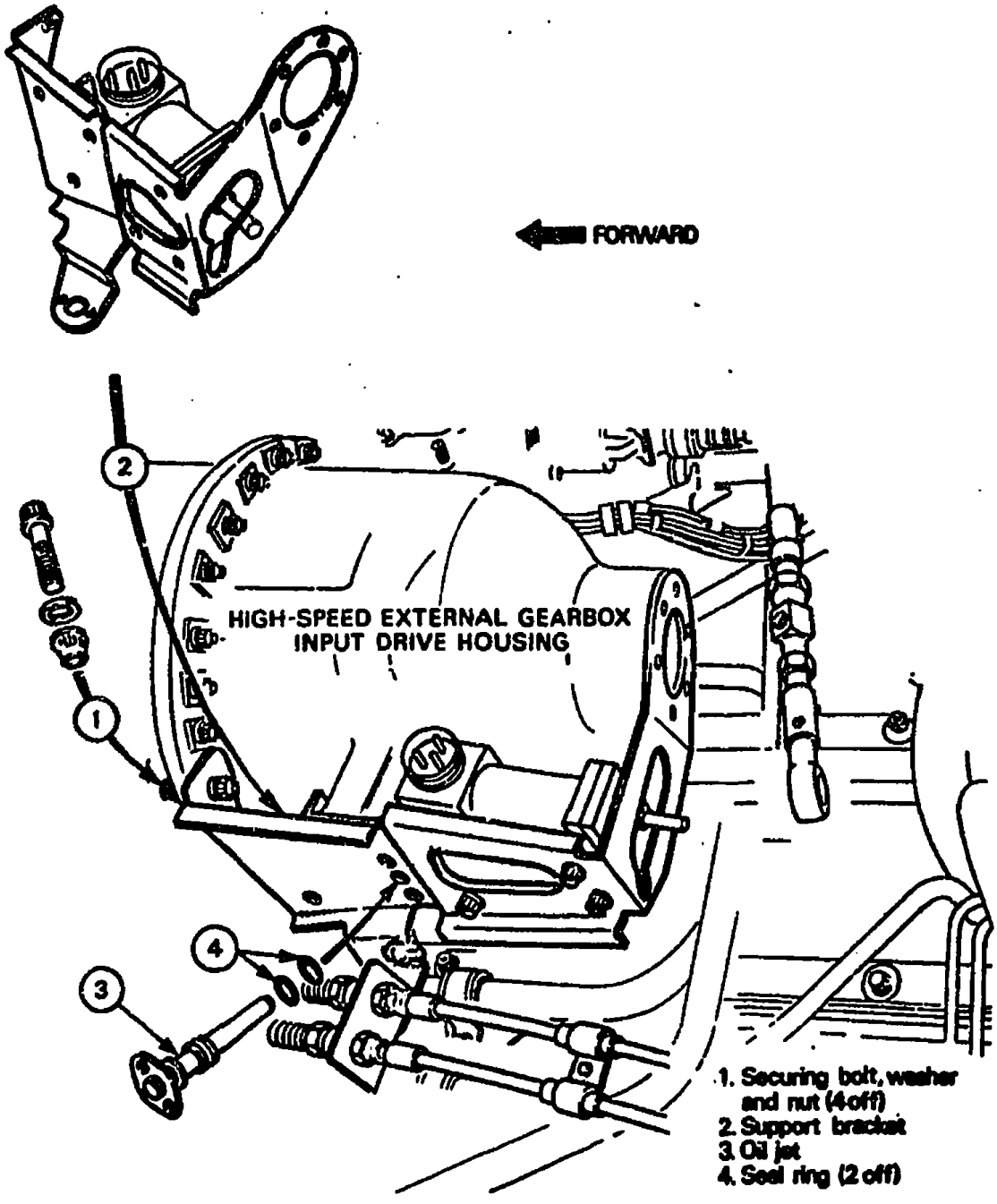
S.B.76-2959 - Introduction of support bracket for F.F.R. box assembly
S.B.76-3364 - Introduction of modified bracket for F.F.R. box assembly
S.B.76-4312 - Introduction of stiffer bracket for H.P.3 bleed valve solenoid and A.I.D.S. throttle transducer.

Referenced Procedures

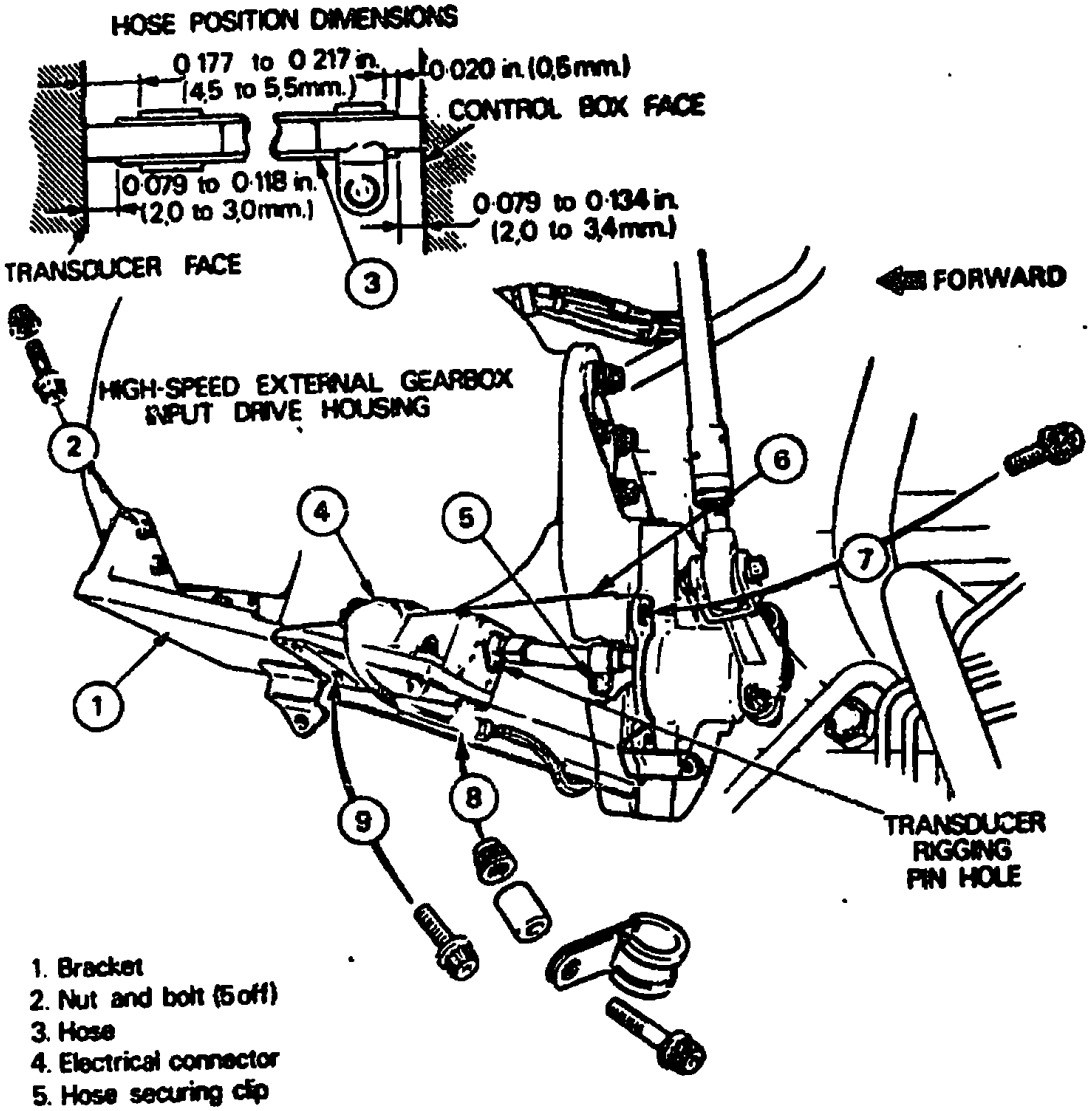
| | |
|---|---|
| 70-02-01 | Identification, Lubrication and Fitting of Rubber Sealing Rings |
| 71-11-00 | Cowlings, Engines No.1 and 3 - Servicing |
| 71-12-01 | L.H. Lower Hinged Cowl - Servicing |
| 71-12-02 | R.H. Lower Hinged Cowl - Servicing |
| 75-32-01 | H.P. Compressor Bleed Valve Control Unit - Maintenance Practices |
| 76-11-02 | Engine Power and Thrust Reverser Control Linkage - Removal/Installation |
| 76-11-00 | Engine Power and Thrust Reverser Control Linkage - Adjustment/Test |




Oil jet removal/installation
Fig.401 (Sheet 1)




Oil jet removal/installation
Fig.401 (Sheet 2)




1. Bracket
2. Nut and bolt (5 off)
3. Hose
4. Electrical connector
5. Hose securing clip
6. Support bracket
7. Bolt (2 off)
8. Clip assembly
9. Bolt (2 off)

44778

Oil jet removal/installation
Fig.401 (Sheet 3)

## Illustrated Parts Catalogue References

The I.P.C. sections where parts disturbed during the following operations can be located are as follows:

| | |
|---|---|
| 72-63-00 | High Speed External Gearbox |
| 76-11-02 | Engine Power and Thrust Reverser Control Linkage |

### A. Remove Input Drive Oil Jet

(1) Equipment required:

HU.19843 Extractor

(2) Tag appropriate APU/GND AIR TO REVERSERS switch.

(3) On Flight Engineers/Second Officers aft circuit breaker panel CB3, zone 215, open and tag appropriate START AIR VALVE circuit breaker.

(4) Tag appropriate ENGINE START panel switch lights.

(5) On pilots overhead circuit breaker panel CB1, zone 210, open and tag appropriate START AIR VALVE and HP 3 BLEED AIR circuit breakers.

(6) Open left-hand hinged cowl 413A or 423A and right-hand hinged cowl 414A or 424A (Ref. 71-11-00) for engines No.1 and 3, or 433AL (Ref. 71-12-01) and 434AR (Ref. 71-12-02) for engine No.2.

(7) Refer to fig.401 (Sheet 1), remove bolt (1).

(8) Release quick-release fasteners (2).

(9) Remove H.P. compressor bleed valve control unit (Ref. 75-32-01).

(10) CAUTION: ENSURE ELECTRICAL CONNECTOR IS FREE FROM LIQUID AND/OR SOLID CONTAMINATION BEFORE DISCONNECTING.
Refer to fig.401 (Sheet 1 or 3), disconnect electrical connector (4).

(11) On engines without S.B.76-4312 proceed as follows:

(a) Refer to fig.401 (Sheet 1), on engines without S.B.76-2959 or S.B.76-3364, remove bolts (3).

(b) Remove fuel flow regulator box (Ref. 76-11-02).

(c) On engines without S.B.76-3364, remove nut and bolt (5).

(d) Refer to fig.401 (Sheet 2), remove bolts, washers and nuts (1) and remove bracket (2).

(12) On engines with S.B.76-4312 proceed as follows:

(a) Refer to fig.401 (Sheet 3), release clip assembly (8).

(b) Remove bolts (7) and (9) and bracket (6).

(c) Remove clip (5).

(d) Remove nuts and bolts (2) and bracket (1).

(13) Refer to fig.401 (Sheet 2), rotate oil jet (3) through 90 degrees and using extractor withdraw oil jet.

B. Prepare for Installation

(1) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid (Inhibited and stabilized 1.1.1. trichloroethane) | BS.4487 1969 | Mil-T-81533 | 1/21 |
| Compressed air supply | | | |
| Clean kerosine | | | |

(2) Refer to fig.401 (Sheet 2), wash oil jet (3) in clean kerosine and ensure oil jet is dry and clear of obstruction by blowing through with moisture free compressed air.

(3) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.
Using degreasing fluid, clean the following mating faces and allow to dry.

(a) Mating faces of F.F.R. box, transducer support bracket and input drive housing.

(b) Mating faces of oil jet and input drive housing.

NOTE: On engines with S.B.76-4312, perform operation (3) (b) only.

(4) Fit and lubricate (Ref. 70-02-01) new seal rings to oil jet (3) and cover (Ref. fig.401 (Sheet 1)).

C. Install Input Drive Housing Oil Jet

(1) Equipment required:

Clean, stiff-bristled brush
33502230 (BLC-3R-05N) — Rigging pin ) Engines with
UT.993 — Rigging pin ) S.B.76-4312
) only

(2) Material required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Jointing compound | DTD.900/4586 (Hylomar light) | - | 426 |

(3) Ensure appropriate systems are tagged as detailed in operations A. (2) through (5).

(4) CAUTION: ENSURE JOINTING COMPOUND DOES NOT ENTER OIL PASSAGE.
Brush apply thin film of jointing compound to the following mating faces and allow compound to dry for a minimum period of 10 minutes.

(a) Mating faces of F.F.R. box, transducer support bracket and input drive housing.

(b) Mating faces of oil jet and input drive housing.

NOTE: On engines with S.B.76-4312, perform operation (4) (b) only.

(5) Refer to fig.401 (Sheet 2), position oil jet (3) in input drive housing.

(6) On engines without S.B.76-4312 proceed as follows:

(a) Position bracket (2) and fit and secure bolts, washers and nuts (1).

(b) Install fuel flow regulator box (Ref. 76-11-02).

(c) Refer to fig.401 (Sheet 1), on engines without S.B.76-2959 or S.B.76-3364, fit and secure bolts (3).

(d) On engines without S.B.73-3364, fit and secure bolt and nut (5).

(7) On engines with S.B.76-4312 proceed as follows:

(a) Refer to fig.401 (Sheet 3), position bracket (1) fitting free end of connecting hose (3) over fuel flow regulator box spindle then fit and secure bolts and nuts (2). Check hose position dimensions.

(b) Rotate hose to align slot in locating plate attached to transducer spindle with rigging hole in transducer body, then insert rigging pin 3502230.

(c) Set throttle controls in rigging position (Ref. 76-11-00) then insert rigging pin UT.993 in control box rigging hole.

(d) Position clip (5) dimensionally as shown in fig.401 (Sheet 3), then tighten to secure hose to control box spindle.

(e) Remove the two rigging pins.

(f) Position bracket (6) and secure with bolts (7) and (9).

(g) Position and secure clip assembly (8).

(8) CAUTION: ENSURE ELECTRICAL CONNECTOR IS FREE FROM LIQUID AND/OR SOLID CONTAMINATION BEFORE CONNECTING.
Refer to fig.401 (Sheet 1 or 3), connect electrical connector (4).

(9) Install H.P. compressor bleed valve control unit (Ref. 75-32-01).

(10) Refer to fig.401 (Sheet 1), secure quick release fasteners (2).

(11) Fit and secure bolt (1).

(12) Remove tags and close circuit breakers opened in operations A.(2) through (5).

(13) Close left-hand hinged cowl 413A or 423A and right-hand hinged cowl 414A or 424A (Ref.71-11-00) for engines No.1 and 3, or 433AL (Ref. 71-12-01) and 434AR (Ref. 71-12-02) for engine No.2.

## HIGH-SPEED EXTERNAL GEARBOX - INSPECTION/CHECK

- Check Drive To H.P Fuel Pump

Referenced Procedures:

| | |
|---|---|
| 71-11-00 | Cowlings, Engines No.1 and 3 - Servicing |
| 71-12-01 | L.H. and R.H. Hinged Cowl - Servicing |
| 72-00-00 | Engine - Servicing |

Illustrated Parts Catalogue References:

The I.P.C. sections where parts disturbed during the following operations can be located are as follows:

| | |
|---|---|
| 72-63-01 | Centrifugal Breather Outlet Duct |

A. Equipment required.

Inspection mirror

B. Open L.H. hinged cowl 413A or 423A for engines No.1 and 3 (Ref.71-11-00) or 433A for engine No.2 (Ref.71-12-01).

C. Refer to fig.601, remove bolts (1).

D. Remove nuts and bolts (2).

E. Remove breather duct (3) and gasket (4)

F. Rotate engine H.P. system, Method 1 (Ref.72-00-00), and using suitable inspection mirror, check forward end of centifugal breather rotor shaft (ref. fig.602) for rotation.

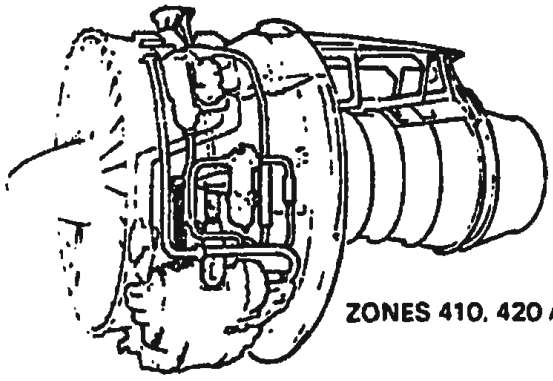
G. Position breather duct (3) and clamp plate (5) on bracket (6). Loosely fit nuts and bolts (2).

H. Fit new gasket (4) between breather duct and H.S. external gearbox.

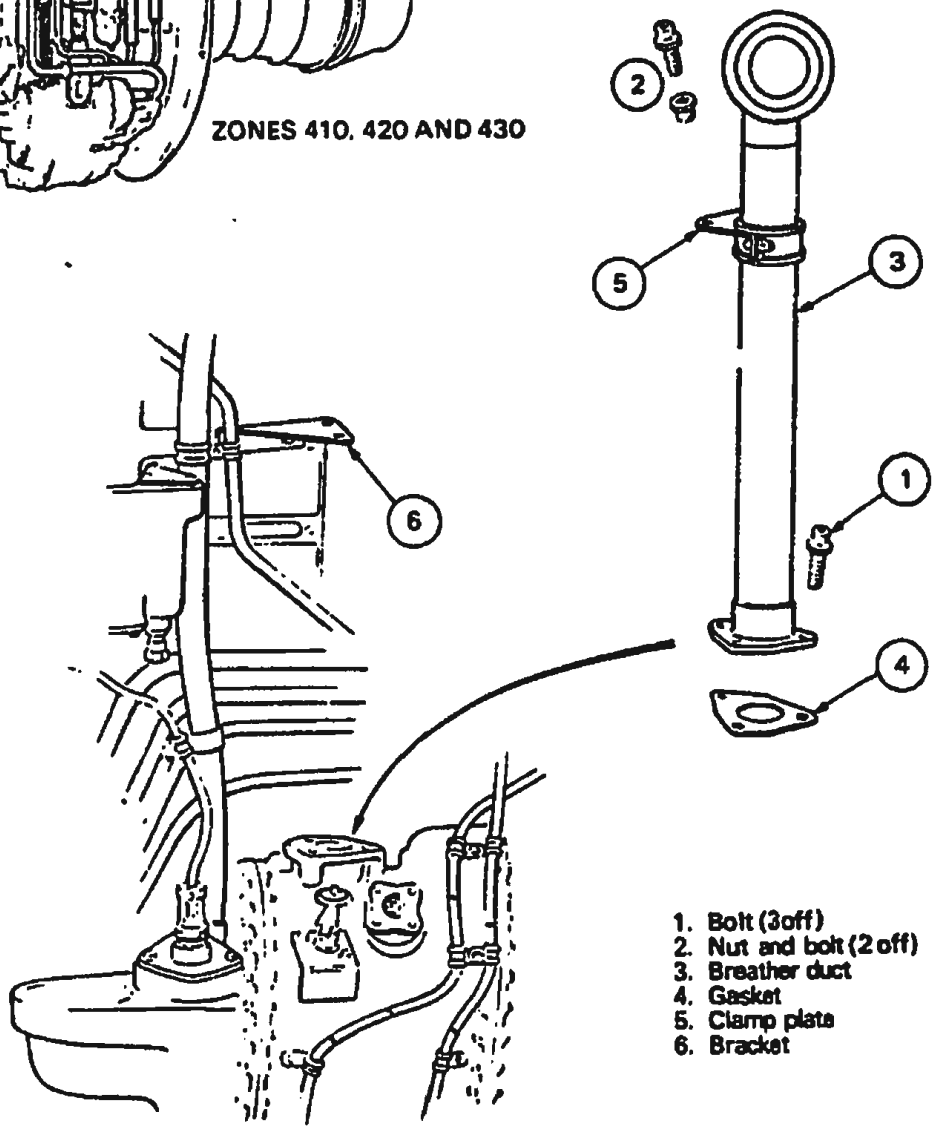
J. Fit and secure breather duct to H.S. external gearbox with bolts (1).

K. Secure nuts and bolts (2).

L. Close L.H. hinged cowl 413A or 423A for engines No.1 and 3 (Ref.71-11-00) or 433A for engine No.2 (Ref.71-12-01).

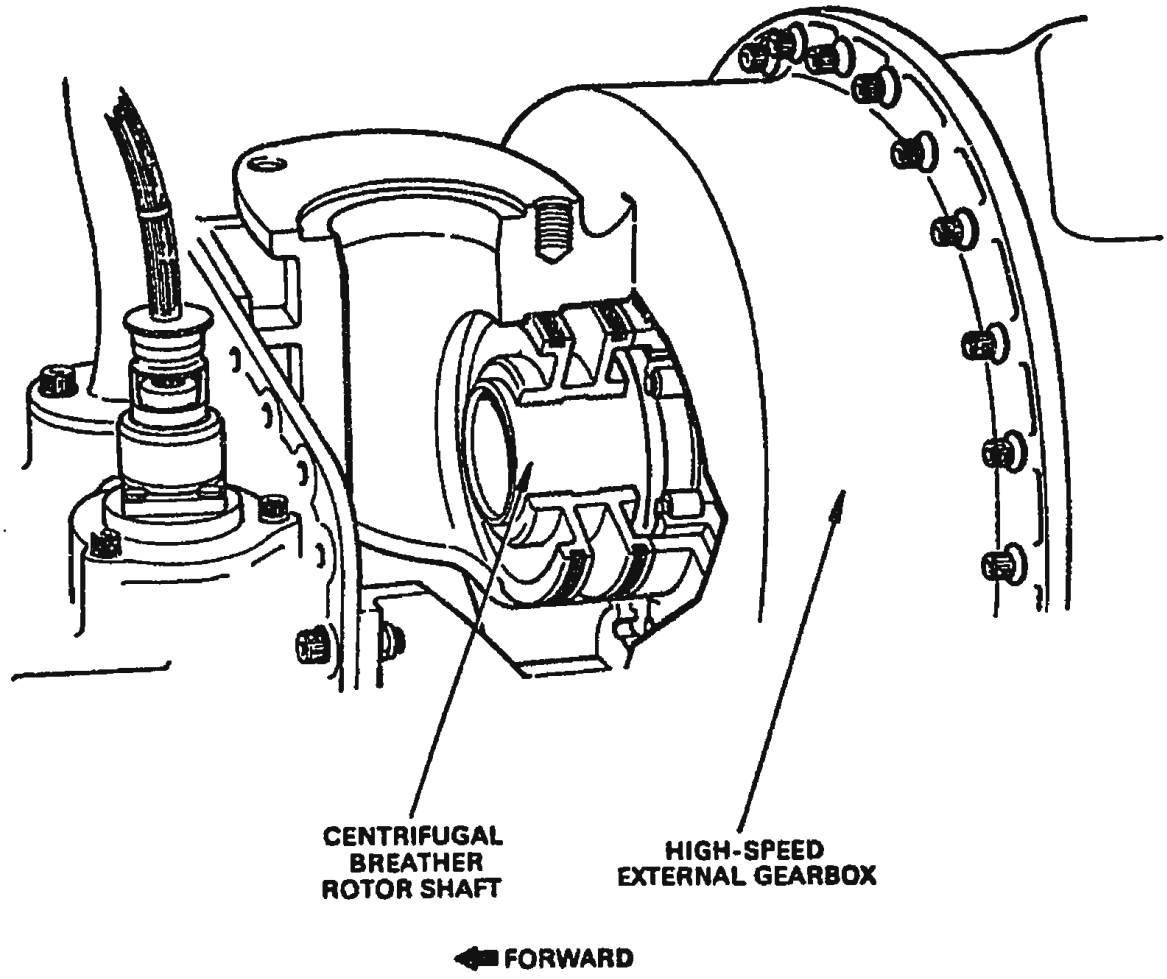


ZONES 410, 420 AND 430




32706

Centrifugal breather duct - Removal/installation
Fig.601



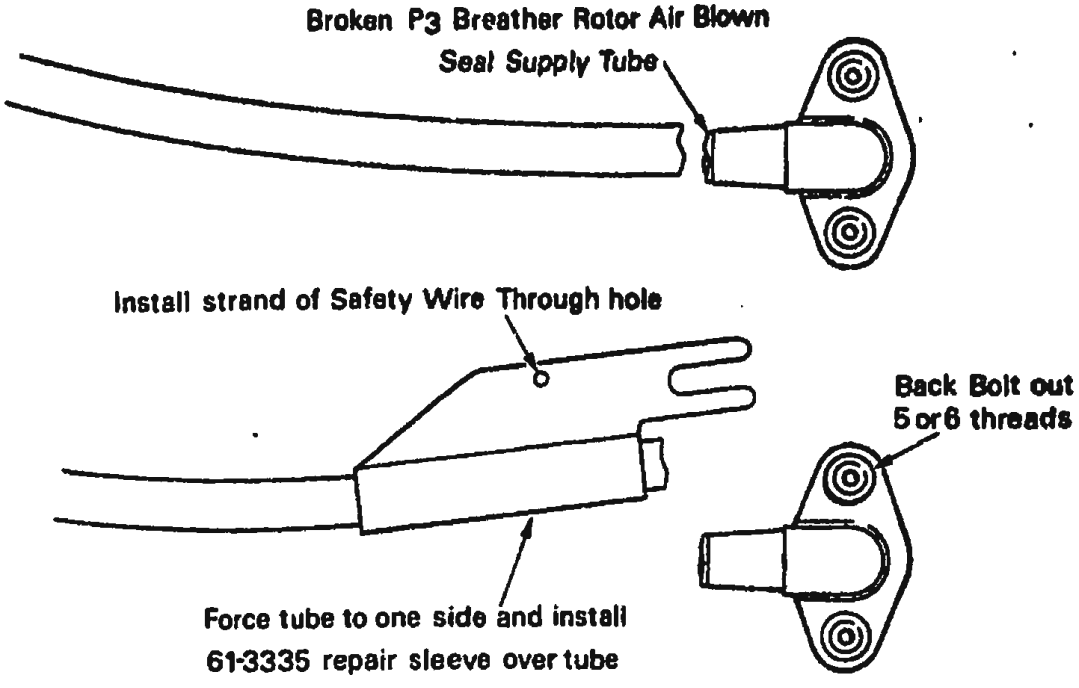

Centrifugal breather rotor shaft
Fig.602

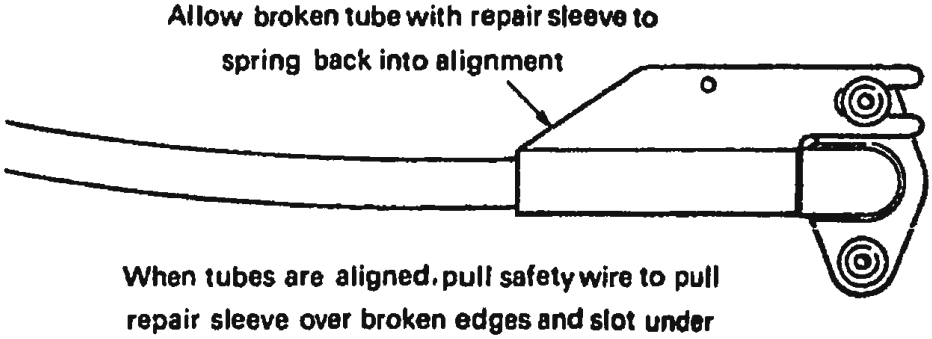
## HIGH SPEED EXTERNAL GEARBOX - APPROVED REPAIRS

### 1. Repair of Broken P3 Air Supply Tube

A. This repair to breather rotor air blown seal P3 air supply line applies a quick fix to line broken at the weld attach point for the breather attach fitting. See figure 801 for installation of repair sleeve.

B. Once the repair sleeve is installed on a broken tube and a ground run is made to ensure that there is no further oil loss (the ground run should be done at ground idle because this is the most critical point for sealing pressures vs internal gearbox pressures) the engine can continue in service without repairs until the next shop visit.


Broken P3 Breather Rotor Air Blown
Seal Supply Tube
Install strand of Safety Wire Through hole
Back Bolt out
5 or 6 threads
Force tube to one side and install
61-3335 repair sleeve over tube




When tubes are aligned, pull safety wire to pull repair sleeve over broken edges and slot under bolt. Tighten bolt and remove wire

NOTE : Notify MCI Engineering of Installation and allow Engine to continue in service with "Quick Fix" until next shop visit

87961

CR
CR
P3 air supply tube repairs
Figure 801

R EFFECTIVITY: ALL
R
050B
1G

R # PRIMARY OIL PUMP ASSEMBLY - REMOVAL/INSTALLATION

R 1. General

R WARNING: 1. THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE
R MAY CAUSE SKIN IRRITATION IF SKIN CONTACT IS
R REPEATED OR PROLONGED.

R 2. IMMEDIATELY AFTER SHUTDOWN ENGINE OIL TEMPERATURE
R REMAINS HIGH, THEREFORE EXTREME CARE MUST BE
R OBSERVED WHEN WORKING NEAR TO, OR ON, ENGINE OIL
R SYSTEM COMPONENTS AND TUBES.

R CAUTION: 1. THE OIL SPECIFIED FOR USE IN THIS OIL SYSTEM IS
R INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF
R RUBBER AND MUST NOT BE ALLOWED TO CONTAMINATE
R THOSE PARTS OF THE ENGINE NOT NORMALLY IN CONTACT
R WITH IT. ANY OIL SPILT DURING SERVICING MUST BE
R WIPED UP IMMEDIATELY.

R 2. CONTAMINATION BY MINUTE AMOUNTS OF CERTAIN
R ALKALINE CLEANING FLUIDS CAN CAUSE COMPLETE
R BREAKDOWN OF THE SYNTHETIC OIL. USE SCRUPULOUSLY
R CLEAN CONTAINERS AND EQUIPMENT.

R 3. DRAINED OIL MUST NOT BE RETURNED TO THE SYSTEM.

R Reprotect any joint flanges, securing features and areas where
R surface protection is damaged or deteriorated, by applying air drying
R enamel of the appropriate colour, on completion of assembly.
R The air drying enamels required are listed in 70-42-12.

R Fit approved blanks to all connectors and apertures exposed during
R removal procedures. Remove blanks before installation of
R respective components.

R For ease of location all illustrations, referred to in this text,
R are grouped together at the end of this section.

R 2. Primary Oil Pump Assembly Removal/Installation

R Service Bulletins referred to:

R 71-2565 - H.S. External Gearbox - Oil filler scupper drain
R tube
R 72-3152 - H.S. External Gearbox - Scupper drain tube
R re-clipping
R 72-4689 - H.S. External Gearbox - Crossed over L.P. turbine
R rear bearing and internal gearbox oil return tubes

R Referenced Procedures:

| | | |
|---|---|---|
| R | 12-12-01 | Engine Oil Replenishment |
| R | 29-00-00 | Hydraulic Power - Maintenance Practices |
| R | 70-02-01 | Identification, Lubrication and Fitting of Rubber Sealing Rings |
| R | 70-42-12 | Standard Practices - Local Surface Protection |
| R | 70-51-00 | Torque Tightening Technique |
| R | 71-00-00 | Power Plant - Adjustment/Test |
| R | 71-11-00 | Cowlings, Engines No.1 and 3 - Servicing |
| R | 71-12-01 | L.H. and R.H. Lower Hinged Cowl - Servicing |
| R | 72-00-06 | H.S. External Gearbox Module - Removal/Installation |
| R | 72-01-00 | Oil System - Servicing and - Removal/Installation |
| R | 72-60-00 | Accessory Section - Servicing |
| R | 79-31-01 | Oil Pressure Transmitter - Maintenance Practices |
| R | 79-31-02 | Oil Filter Pressure Differential Switch - Maintenance Practices |
| R | 79-31-03 | Low Oil Pressure Warning Switch - Maintenance Practices |
| R | 79-34-01 | Oil Temperature Bulb - Maintenance Practices |
| R | 79-37-01 | Oil Quantity Transmitter - Maintenance Practices |

R Illustrated Parts Catalogue References:

R The I.P.C. sections where parts disturbed during the following
R operations can be located are as follows:

| | | |
|---|---|---|
| R | 29-11-06 | Engine Mounted Hydraulic Tubes |
| R | 72-61-00 | H.S. External Gearbox |
| R | 79-21-05 | Oil System Tubes and Fittings |

R A. Prepare to Remove Oil Tank Cover and Primary Oil Pump
R Assembly

R (1) Open and tag relevant circuit breakers on pilot's
R overhead panel CB1, zone 210:

R (a) ENGINE START

R Eng.1 ENGINE START CONT (E13)
R Eng.2 ENGINE START CONT (E14)
R Eng.3 ENGINE START CONT (E15)

R (b) FIRE EXTINGUISHERS

R Eng.1 MAIN and ALT (C10, 11)
R Eng.2 MAIN and ALT (C12, 13)
R Eng.3 MAIN and ALT (C14, 15)

R (c) HYD PUMP & FIREWALL SHUTOFF VALVE CONT; (No.2
R Eng only)

R SYS B (L16)

R (2) Open and tag relevant circuit breakers on flight
R engineer's vertical circuit breaker panel CB.3,
R zone 215

R (a) INSTR & CONTROLS - ALL ENGINES

R OIL PRESS (R10)
R OIL QTY (R14)

R (b) OIL TEMP

R ENG.1 (P1)
R ENG.2 (P7)
R ENG.3 (P13)

R (c) OIL LO PRESS LIGHT

R ENG.1 (N5)
R ENG.2 (N11)
R ENG.3 (N17)

R (3) Open left hand hinged cowl, 413A or 423A for engines
R No.1 and 3 (Ref. 71-11-00) or 433A for engines No.2
R (Ref. 71-12-01).

B. Remove Oil Tank Cover and Primary Oil Pump Assembly

(1) Equipment required

HU19872 Extractor (1 off)
Clean receptacle - minimum capacity

| | |
|---|---|
| 6.0 | US gallons |
| 5.0 | Imperial gallons |
| 23,0 | litres |

(2) Refer to fig.401, and using drain plug (1), drain oil tank (Ref. 72-01-00, Servicing).

(3) Remove oil pressure filter element (2) (Ref. 72-01-00, Removal/Installation).

(4) Remove oil filter pressure differential switch (3) (Ref. 79-31-02).

(5) Remove oil temperature bulb (4) (Ref. 79-34-01).

(6) Remove low oil pressure warning switch (10) (Ref. 79-31-03).

(7) Remove oil pressure transmitter (11) (Ref. 79-31-01).

(8) Remove oil quantity transmitter (13) (Ref. 79-37-01).

(9) Remove oil filler drain tube (12) (Ref.72-00-06).

R (10) CAUTION: MAKE SURE THE PRESSURE PUMP COVER AND STRAINER
R ARE REMOVED BEFORE THE OIL TANK COVER IS
R REMOVED. THE PRESSURE PUMP STRAINER AND COVER
R CAN BE DAMAGED IF THIS IS NOT DONE.

R (a) Remove the pressure pump strainer (Ref.72-01-00).

(11) WARNING: DEPRESSURIZE ACCUMULATORS BEFORE LOOSENING ANY HYDRAULIC LINES. VERIFY ZERO P.S.I. AT RESERVOIR PRESSURE GAUGE ON HYDRAULIC SERVICE PANEL (REF. 29-00-00).

CAUTION: USE EXTREME CARE TO PREVENT DAMAGING HYDRAULIC HOSES THROUGH BENDING, KINKING OR TWISTING.

On No.2 engine only:

(a) Disconnect B1 pump hydraulic hoses (3 off) at the L.H. side Q.E.C. disconnect point. Install approved protective caps to prevent contamination of hydraulic system.

(b) Remove bolts (4 off) which secure hydraulic hoses mounting bracket to support bracket on fan casing, allowing hoses to be moved forward, to provide clearance when removing oil tank cover assembly.

(12) Disconnect and remove oil tank front cover mounted tubes (5) through (9) and (14).

(13) Engines with S.B.72-4689, refer to fig.401 (Sheet 2), remove transfer plate (15) and tube (16) (Ref. 72-00-06).

(14) Refer to fig.402, remove nuts, bolts and washers securing oil tank cover and pump assembly (1) to H.S. gearbox assembly (2), noting positions of various support brackets.

(15) Insert bolts into jacking points at three positions (N) and, after visually checking joint flange to confirm all attachment bolts have been removed, sequentially and in equal, gradual increments, tighten three jacking bolts, thus separating oil tank cover and pump assembly from H.S. gearbox assembly.

(16) Removing oil tank cover and pump assembly from H.S. gearbox assembly, keep aligned until clear of oil pump drive quillshaft and oil connectors (Ref. fig.403 and 404).

(17) Remove H.S. gearbox assembly to oil pump housing main oil feed connector (Ref. fig.403).

(a) Fit HU19872 Extractor

(i) Back off extractor nut (1).

(ii) Fit extractor locating claw (2) around main oil feed connector (3) and position sleeve (4) on H.S. gearbox assembly front face.

(b) Tighten extractor nut against washer (5), withdrawing connector from H.S. gearbox assembly.

(c) Remove oil feed connector from extractor.

(d) Remove and discard four seal rings (6) from main oil feed connector (3).

C. Remove Oil Pump Drive Connector, Seal Housing and Quillshaft (Ref. fig.403)

(1) Remove oil pump drive connector (7) from seal housing (8).

(2) Remove and discard four seal rings (9) from oil pump drive connector (7).

(3) Remove three bolts (10) securing seal housing (8) to H.S. gearbox assembly and remove seal housing.

(4) Remove and discard seal ring (11) from seal housing (8).

(5) Withdraw oil pump drive quillshaft (12) from oil pump drive gearshaft (13) in H.S. gearbox assembly.

D. Remove Oil Pump Assembly from Oil Tank Cover Assembly (Ref. fig.404)

(1) Equipment required:

HU25324 Extractor (1 off)

(2) Refer to fig.404:

(a) Remove oil pump attachment bolt and washer (1) from two positions marked D.

(b) Remove oil pump attachment bolt and washer (2) from twelve positions marked E.

(3) Remove oil pump assembly (3) from oil tank cover assembly (4).

(4) Remove oil pump to oil tank cover connector assembly (5).

(a) Fit HU25324 Extractor

(i) Back off extractor nut (6).

(ii) Fit extractor locating claw (7) around oil pump to cover connector (5), slide sleeve (8) to abut oil tank cover (4).

(b) Tighten extractor nut against washer (9), withdrawing oil pump to cover connector assembly (5) from oil tank cover (4).

(c) Remove oil tank to cover connector assembly from extractor.

(d) Remove and discard four seal rings (10) from oil pump to cover connector (4).

E. Install Oil Pump Assembly on Oil Tank Cover Assembly (Ref. fig.404)

(1) Materials required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid | | | |
| Methylethylketone (M.E.K.) | B.S.1940 1968 | - | 135 |
| or Acetone | B.S.509 1964 | - | 150 |
| or Methylene Chloride (Dichloromethane) | B.S.1994 1953 | - | 169 |
| Marking compound Prussian Blue | - | - | 2/41 |

(2) WARNING: ENSURE ADEQUATE VENTILATION WHEN USING DEGREASING FLUID. AVOID SKIN CONTACT AND INHALING THE VAPOUR.

CAUTION: TAKE CARE WHEN APPLYING THE FLUID BECAUSE SURFACE PROTECTION WILL BE AFFECTED. ANY AFFECTED AREAS MUST BE REPROTECTED IN ACCORDANCE WITH 70-42-12.

(a) Using degreasing fluid, clean mating faces of oil pump assembly and oil tank cover assembly. Allow to dry.

(b) Apply thin, consistent coating of marking compound to joint face of oil tank cover assembly.

(c) Carefully align and fit oil pump assembly to oil tank cover exerting firm hand pressure to maintain alignment and contact between the joint faces.

(d) Maintaining hand pressure, carefully slide the joint faces slightly out of alignment then re-align the assemblies.

(e) Carefully remove oil pump assembly from oil tank cover assembly.

(f) Inspect joint faces for indication that 80 per cent (minimum) contact, evenly distributed, is attainable between faces.

(g) Clean all traces of marking compound from both joint faces, using degreasing fluid. Allow to dry.

(3) Refer to fig.404, fit (Ref. 70-02-01) new seal ring (10 to four grooves of oil pump to cover connector (5). Fit connector assembly into respective bore in oil tank cover assembly, ensure fully located.

(4) CAUTION: DO NOT APPLY JOINTING COMPOUND TO OIL PUMP ASSEMBLY AND OIL TANK COVER ASSEMBLY JOINT FACES.

Align oil pump assembly (3) with oil tank cover assembly (4). Fit into position ensuring oil pump to cover connector locates in respective bore and oil pump assembly locates with two hollow pins.

(5) Check, to ensure pump assembly (3) is fully seated on oil tank assembly (4) then, referring to fig.404.

(a) Fit bolt and washer (1) in two positions marked D.

(b) Fit bolt and washer (2) in twelve positions marked E.

(c) Tighten bolts, gradually in sequence shown and finally torque tighten bolts to standard loading (Ref. 70-51-00).

(6) Check oil pump assembly spur gears rotate freely.

F. Install Quillshaft, Seal Housing and Oil Pump Drive Connector (Ref. fig.403)

(1) Install quillshaft (12) into position in oil pump drive gearshaft (13). Ensure quillshaft fully located in gearshaft.

(2) Fit (Ref. 70-02-01) new seal ring (11) into groove on oil pump drive seal housing (8).

(3) Fit seal housing (8) into position over quillshaft (12). Ensure housing fully located on H.S. external gearbox assembly and attachment bolt holes aligned.

(4) Fit bolts (10) and torque tighten to standard loading (Ref. 70-51-00).

(5) Fit (Ref. 70-02-01) new seal ring (9) to four grooves on oil pump drive connector (7) then fit connector assembly into position over quillshaft. Ensure connector assembly fully located in seal housing.

(6) Fit (Ref. 70-02-01) new seal ring (6) to four grooves on H.S. gearbox assembly to oil pump housing main oil feed connector (3), then fit connector assembly into respective bore in H.S. gearbox assembly front face. Ensure main oil feed connector fully located.

G. Install Oil Tank Cover and Primary Oil Pump Assembly

(1) Materials required:

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Degreasing fluid | | | |
| Methylethylketone (M.E.K.) | B.S.1940 1968 | - | 135 |
| or Acetone | B.S.509 1964 | - | 150 |
| or Methylene Chloride (Dichloromethane) | B.S.1994 1953 | - | 169 |
| Jointing compound | DTD.900/4586 (Hylomar light) PL32 | - | 4/46 |

Clean engine oil (Ref. 12-12-01)

(2) WARNING: ENSURE ADEQUATE VENTILATION WHEN USING DEGREASING FLUID. AVOID SKIN CONTACT AND INHALING THE VAPOUR.

CAUTION: TAKE CARE WHEN APPLYING THE FLUID BECAUSE SURFACE PROTECTION WILL BE AFFECTED. ANY AFFECTED AREAS MUST BE REPROTECTED IN ACCORDANCE WITH 70-42-12.

Using degreasing fluid, clean joint faces of H.S. gearbox assembly, oil tank cover assembly, brackets and corresponding positions on front and rear of flanges (Ref. fig.402). Allow to dry.

(3) CAUTION: DURING ASSEMBLY ENSURE JOINTING COMPOUND DOES NOT ENTER THE ENGINE INTERIOR GENERALLY NOR INTO OIL PASSAGES IN PARTICULAR.

Apply jointing compound to joint faces of H.S. gearbox assembly, oil tank cover assembly, brackets and corresponding positions on flanges (Ref. fig.402). Allow compound to dry for a minimum of ten minutes.

(4) Aligning oil tank cover and pump assembly with H.S. gearbox, fit into position ensuring oil pump drive quillshaft enters pump spur gear and correctly engages splines. Ensure oil connectors locate in respective bores and three dowels locate in respective holes, at positions marked M in flange (Ref. fig.402).

(5) Check to ensure cover assembly is fully seated and attachment bolt holes are aligned.

(6) Position brackets and fit bolts, washers and nuts at respective locations (Ref. fig.402) then sequentially (Ref. 70-51-00), tighten all nuts and bolts securing oil tank cover and pump assembly to H.S. gearbox assembly. Torque tighten to standard loading (Ref. 70-51-00).

(7) Engines without S.B.72-4689, refer to fig.401 (Sheet 1) and, after fitting (Ref. 70-02-01) new seal rings, install and connect oil tank front cover mounted tubes (5) through (9) and (14). Torque load bolts and connectors to standard loading (Ref. 70-51-00).

(8) Engines with S.B.72-4689, refer to fig.401 (Sheet 2) and, after fitting (Ref. 70-02-01) new seal rings.

(a) Fit transfer plate (15) to H.S. gearbox assembly (Ref. 72-00-06).

(b) Install and connect oil tank front cover mounted tubes (5) through (9), (14) and (15). Torque load bolts and connectors to standard loading (Ref. 70-51-00).

(9) CAUTION: USE EXTREME CARE TO PREVENT DAMAGING HYDRAULIC HOSES THROUGH BENDING, KINKING OR TWISTING.
On No.2 engine only:

(a) Fit and secure four bolts securing hydraulic hoses mounting bracket to support bracket on fan casing at L.H. side Q.E.C. disconnect point. Torque tighten bolts to standard loading (Ref. 70-51-00).

(b) Connect and secure hydraulic hoses (3 off) at L.H. side Q.E.C. disconnect point. Torque load connectors to standard loading (Ref. 70-51-00).

R (10) Install the Pressure Pump Strainer (Ref.72-01-00).

(11) Fit and secure oil filler drain tube (12) (Ref. 72-00-06).

(12) Install oil quantity transmitter (13) (Ref. 79-37-01).

(13) Install oil pressure transmitter (11) (Ref. 79-31-01).

(14) Install low oil pressure warning switch (10) (Ref. 79-31-03).

(15) Install oil temperature bulb (4) (Ref. 79-34-01).

(16) Install oil filter pressure differential switch (3) (Ref. 79-31-02).

(17) Install oil pressure filter element (2) (Ref. 72-01-00, Removal/Installation).

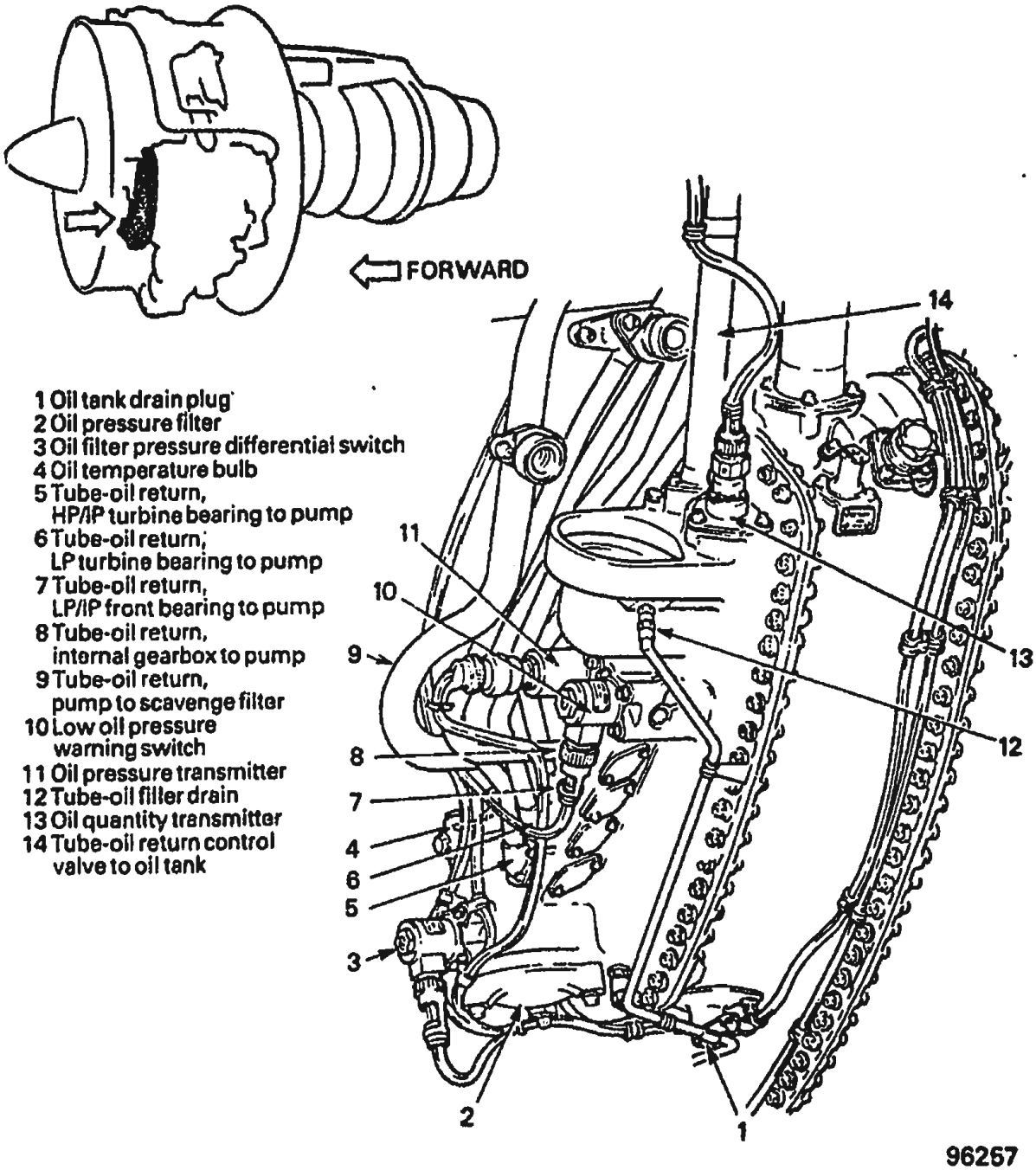
(18) Prime oil system (Ref. 72-60-00).

(19) Replenish oil tank with clean engine oil (Ref. 12-12-00.

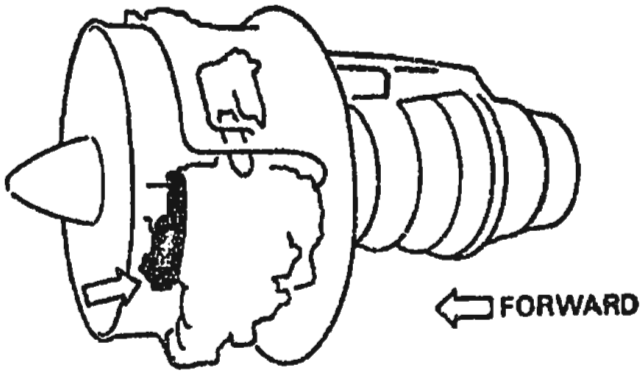
(20) Close left hand hinged cowl 413A or 423A for engines No.1 and 3 (Ref. 71-11-00) or 433A for engine No.2 (Ref. 71-12-01).

(21) Remove tags and close circuit breakers isolated in para.2.A.(1) through (2) (c).

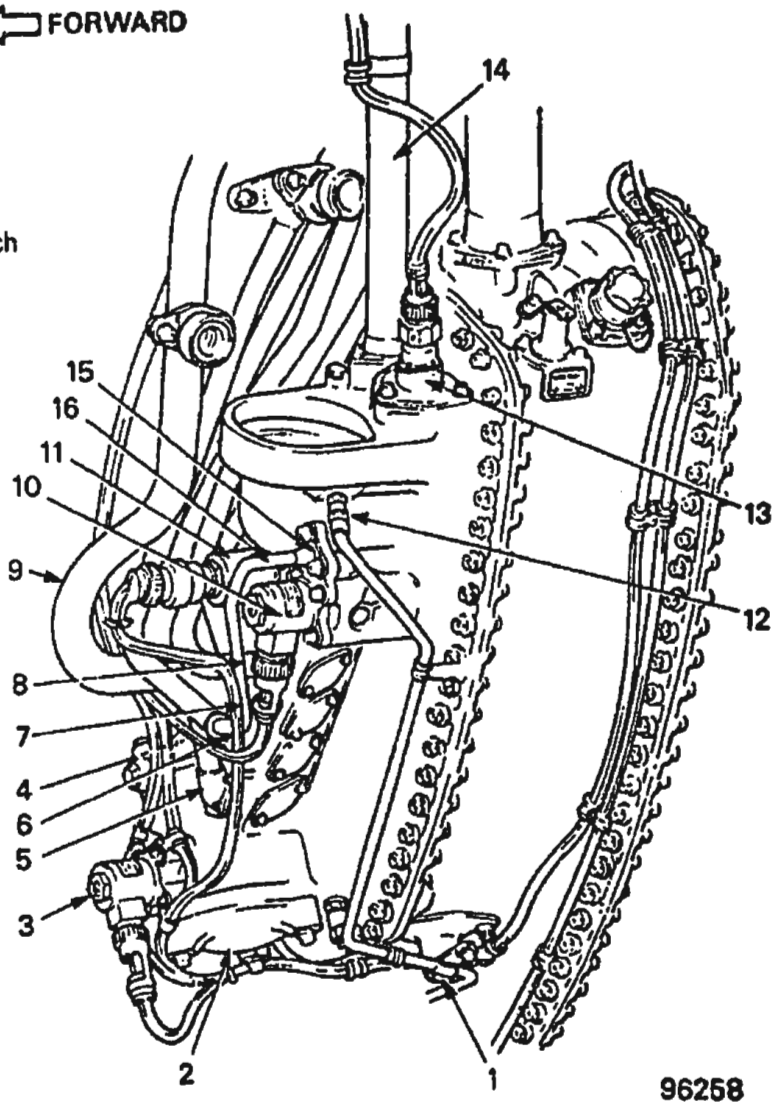
(22) Perform Oil Leak Test No.2 (Ref. 71-00-00) and during engine start-up, check oil pressure and temperature indicating and warning systems.


FORWARD
1 Oil tank drain plug
2 Oil pressure filter
3 Oil filter pressure differential switch
4 Oil temperature bulb
5 Tube-oil return, HP/IP turbine bearing to pump
6 Tube-oil return, LP turbine bearing to pump
7 Tube-oil return, LP/IP front bearing to pump
8 Tube-oil return, internal gearbox to pump
9 Tube-oil return, pump to scavenge filter
10 Low oil pressure warning switch
11 Oil pressure transmitter
12 Tube-oil filter drain
13 Oil quantity transmitter
14 Tube-oil return control valve to oil tank
96257

R Oil tank front cover mounted components and tubes -
R Removal/Installation - Engines without S.B.72-4689
R Fig.401 (Sheet 1)

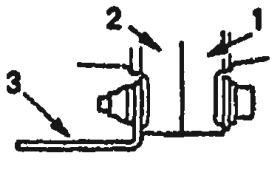



1 Oil tank drain plug
2 Oil pressure filter
3 Oil filter pressure differential switch
4 Oil temperature bulb
5 Tube-oil return
HP/IP turbine bearing to pump
6 Tube-oil return
internal gearbox to pump
7 Tube-oil return
LP/IP front bearing to pump
8 Tube-oil return
LP turbine bearing to pump
9 Tube-oil return
pump to scavenge filter
10 Low oil pressure warning
switch
11 Oil pressure transmitter
12 Tube-oil filler drain
13 Oil quantity transmitter
14 Tube-oil return
control valve to oil tank
15 Transfer plate
16 Tube-transfer plate
to tube-oil return

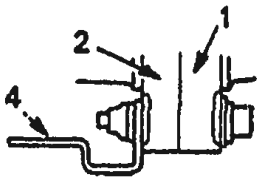



R Oil tank front cover mounted components and tubes -
R Removal/Installation - Engines with S.B.72-4689
R Fig.401 (Sheet 2)

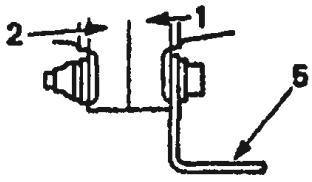
R EFFECTIVITY: ALL



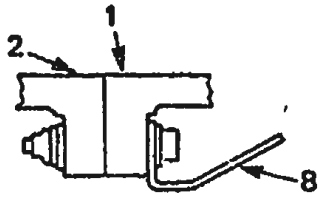

SECTIONED VIEW AT A



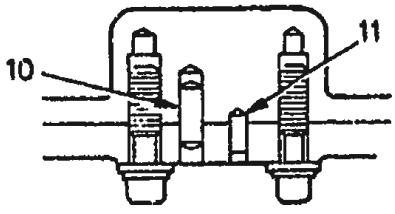

SECTIONED VIEW
AT 3 POSITIONS MARKED B



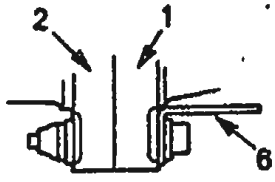

SECTIONED VIEW AT C



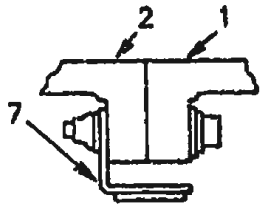

SECTIONED VIEW AT J
S B 71-2565



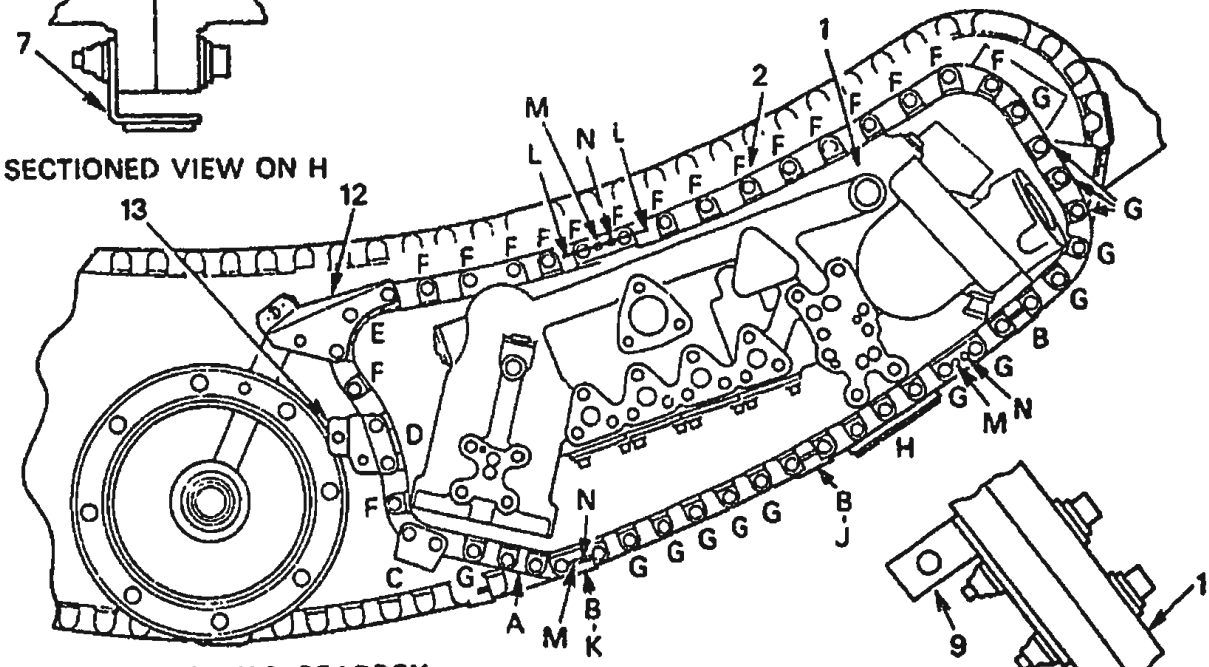

SECTIONED VIEW L-L



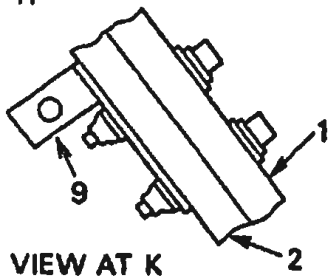

SECTIONED VIEW AT C
SB 71-2565




SECTIONED VIEW ON H




PART VIEW ON H S GEARBOX
ASSEMBLY FRONT FACE




SECTIONED VIEW AT K
SB72-3152

96269

R Oil tank cover and pump assembly - Removal/Installation
R Fig.402 (Sheet 1)

R EFFECTIVITY: ALL

1 Oil tank cover and pump assembly
2 HS external gearbox assembly
3 Bracket-LT harness clipping (pre SB 71-2565)
4 Bracket-LT harness clipping (pre SB71-2565)
5 Bracket-LT harness clipping (pre SB71-2565)
6 Bracket-LT harness clipping (post SB71-2565)
7 Bracket-angle identification plate
8 Bracket-oil drain tube (post SB71-2565)
9 Bracket-oil drain tube (post SB72-3152)
10 Dowel-locating (3 off at positions marked M)
11 Insert-jacking point (3 off at positions marked N)
12 Bracket-fire detector
13 Bracket-LT harness

BRACKETS AND ATTACHING PARTS DETAIL

| SB | POSITION | FIG 402 ITEM NUMBERS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | BRACKET | QTY | BOLT | QTY | NUT | QTY | WASHER | QTY |
| | *A | 08-260 | 1 | 08-416 | 2 | 08-426 | 2 | 08-422 | 2 |
| 71-2565 | A | DELETED | NIL | 08-416 | 2 | 08-426 | 2 | 08-422 | 4 |
| | *Bx3 | 08-360 | 3 | 08-416 | 6 | 08-426 | 6 | 08-422 | 6 |
| 71-2565 | Bx2 | DELETED | NIL | 08-416 | 4 | 08-426 | 4 | 08-422 | 8 |
| 72-3152 | Bx1 | ——— | NIL | 08-416 | 2 | 08-426 | 2 | 08-422 | 4 |
| | C | 08-320 | 1 | 08-416 | 2 | 08-426 | 2 | 08-422 | 2 |
| 71-2565 | C | 08-320 | 1 | 08-416 | 2 | 08-426 | 2 | 08-422 | 2 |
| | D | 08-300 | 1 | 08-402 | 2 | — | — | — | — |
| 71-2565 | D | 08-300 | 1 | 08-402 | 2 | — | — | — | — |
| | E | 08-380 | 1 | 08-402 | 3 | — | — | — | — |
| | F | ——— | — | 08-402 | 17 | — | — | 08-412 | 17 |
| | G | ——— | — | 08-416 | 14 | 08-426 | 14 | 08-422 | 28 |
| | *H | 08-393 | 1 | 08-416 | 3 | 08-426 | 3 | 08-422 | 3 |
| 71-2565 | J | 08-280 | 1 | 08-416 | 2 | 08-426 | 2 | 08-422 | 2 |
| 72-3152 | *K | 08-270 | 1 | 08-416 | 2 | 08-426 | 2 | 08-422 | 2 |

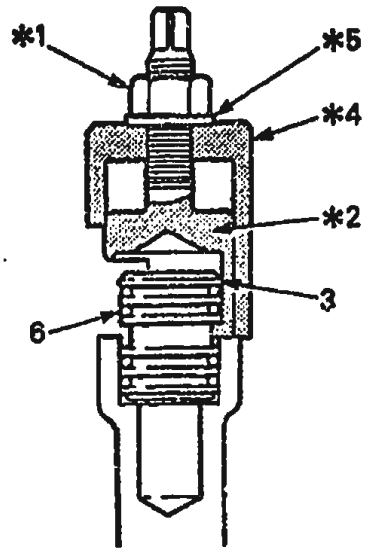
*BRACKETS FITTED ON REAR OF FLANGE

OMIT WASHERS FROM BRACKET POSITIONS

96260

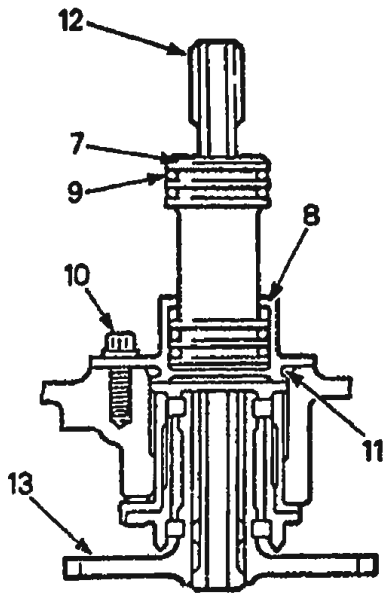
R Oil tank cover and pump assembly - Removal/Installation
R Fig.402 (Sheet 2)

R EFFECTIVITY: ALL
R
050B 1A



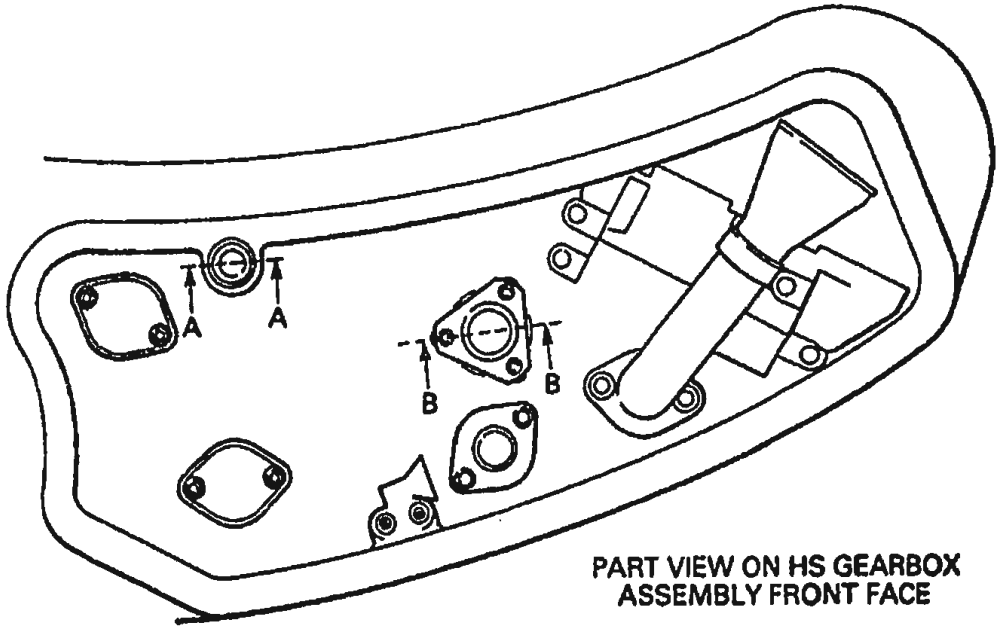

SECTIONED VIEW AA
(Extractor fitted)

* Parts of extractor




SECTIONED VIEW BB

1 Extractor nut
2 Locating claw
3 Main oil feed connector
4 Sleeve
5 Washer
6 Seal ring (4 off)
7 Oil pump drive connector
8 Seal housing oil pump drive
9 Seal ring (4 off)
10 Bolts (3 off)
11 Seal ring
12 Oil pump drive quillshaft
13 Oil pump drive gearshaft



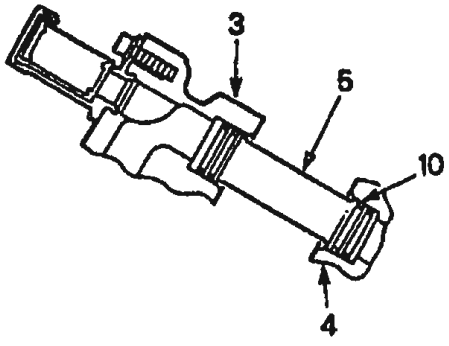

PART VIEW ON HS GEARBOX
ASSEMBLY FRONT FACE

96261

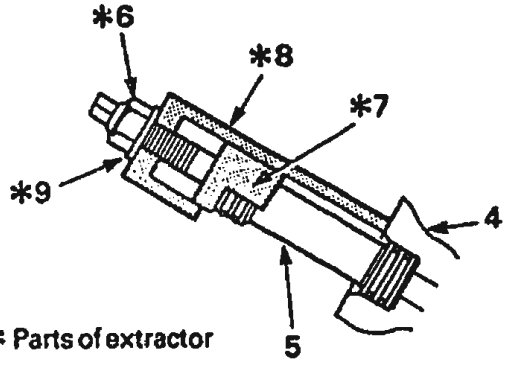
R Oil pump drive quillshaft, seal housing and connectors -
R Removal/Installation
R Fig.403

R EFFECTIVITY: ALL
R
050B 1A

1 Bolt and washer (2 off)
2 Bolt and washer (12 off)
3 Oil pump assembly
4 Oil tank cover assembly
5 Oil pump to cover connector assembly
6 Extractor nut
7 Locating claw
8 Sleeve
9 Washer
10 Seal ring (4 off)

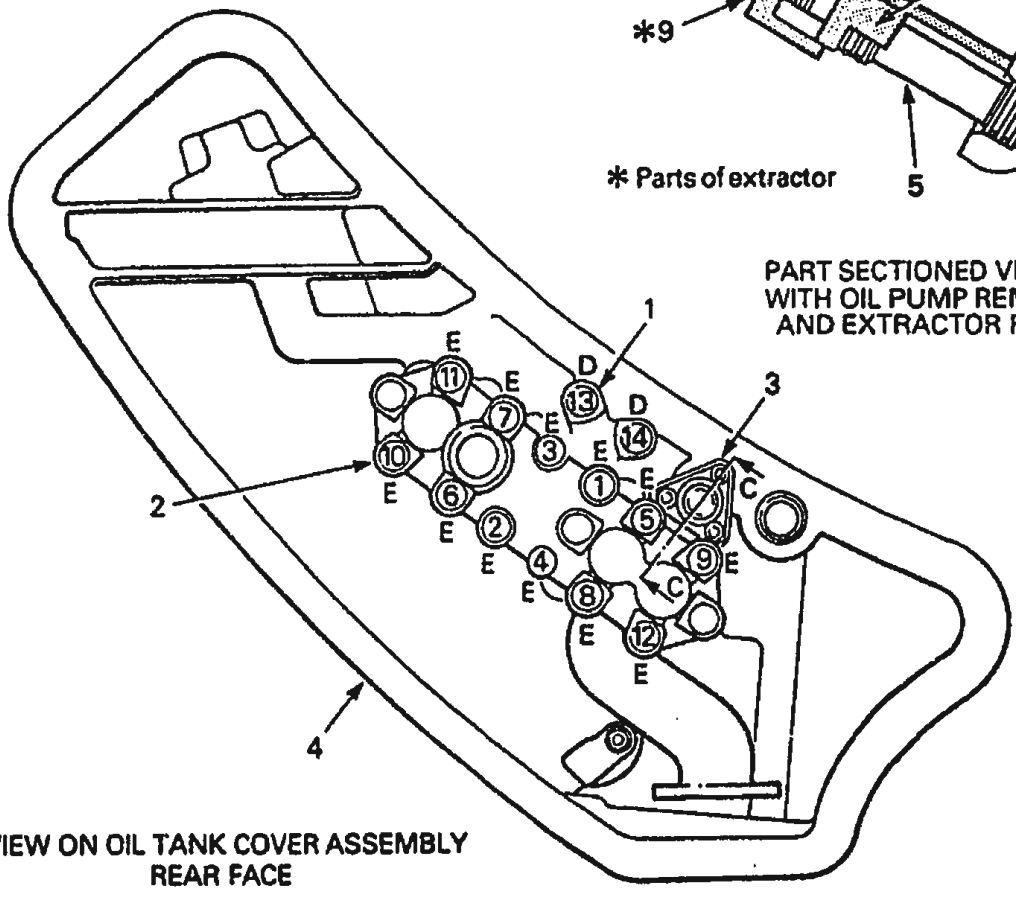



SECTIONED VIEW CC




* Parts of extractor

PART SECTIONED VIEW CC
WITH OIL PUMP REMOVED
AND EXTRACTOR FITTED




VIEW ON OIL TANK COVER ASSEMBLY
REAR FACE

96262

R Oil pump assembly and oil tank cover assembly - Removal/Installation
R Fig.404

R EFFECTIVITY: ALL
R
050B 1A

R # OIL TANK CHECK VALVE - REMOVAL/INSTALLATION

R 1. General

R WARNING: 1. THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE
R CAN CAUSE IRRITATION AFTER PROLONGED OR REPEATED
R SKIN CONTACT.

R 2. IMMEDIATELY AFTER SHUTDOWN ENGINE OIL TEMPERATURE
R REMAINS HIGH. THEREFORE, EXTREME CARE MUST BE
R OBSERVED WHEN WORKING NEAR TO OR ON THE ENGINE
R OIL SYSTEM COMPONENTS AND TUBES.

R CAUTION: 1. THE OIL SPECIFIED FOR USE IN THIS OIL SYSTEM IS
R INJURIOUS TO PAINTWORK AND CERTAIN TYPES OF RUBBER
R AND MUST NOT BE ALLOWED TO CONTAMINATE THOSE PARTS
R OF THE ENGINE NOT NORMALLY IN CONTACT WITH IT.
R ANY OIL SPILT DURING SERVICING MUST BE WIPED UP
R IMMEDIATELY.

R 2. CONTAMINATION BY MINUTE AMOUNT OF CERTAIN ALKALINE
R CLEANING FLUIDS CAN CAUSE COMPLETE BREAKDOWN OF
R THE SYNTHETIC OIL. USE SCRUPULOUSLY CLEAN
R CONTAINERS AND EQUIPMENT.

R A. Illustrated Parts Catalogue Reference

R The I.P.C. sections where parts disturbed during the
R following operations can be located as follows:

R 72-63-00 High Speed (H.S.) External Gearbox

R B. Referenced Procedures

R 12-12-01 Engine Oil Replenishment
R 70-02-01 Identification, Lubrication and Fitting of Rubber
R Sealing Rings
R 70-51-00 Torque Tightening Technique
R 71-11-00 Cowling, Engines No.1 and No.3 - Servicing
R 71-12-01 Engine No.2, Hinged Cowling L.H. and R.H.
R Lower - Servicing
R 72-01-00 Oil System - Servicing

R C. Service Bulletins refered to:

R 72-3665 Oil tank filler with additional spacer

R 2. Remove Oil Tank Check Valve

R A. Equipment required

R XUT30835 Extractor

R Clean receptacle - Minimum capacity 6 U.S. gallons
R (5 Imperial gallons, 23 Litres)

R B. Remove valve

R (1) Open L.H. hinged cowl, 413A or 423B for engines No.1
R and No.3 (Ref.71-11-00) or 433AL for engine No.2 (Ref.
R 71-12-01).

R (2) Drain engine oil tank (Ref.72-01-00).

R (3) Refer to fig.401, unclip filler cap retaining chain
R from keywasher (1).

R (4) Remove bolts (2) and keywasher (1) securing filler cap
R housing (3) to oil tank cover. Remove housing as an
R assembly from oil tank cover and place on a clean work
R surface.

R (5) Remove and discard gasket (5).

R (6) On engines with S.B.72-3665 remove spacer (6) and
R additional gasket (7). Discard gasket.

R (7) Fit temporary blank to oil tank cover aperture to
R prevent ingress of contaminants.

R (8) Remove filler cap (8) from adapter (9).

R (9) Using extractor, remove filler cap adapter (9) from
R filler cap housing (3). Remove extractor.

R (10) Remove and discard seal ring (10) from filler cap
R adapter (9).

R (11) Remove bolts (11) securing valve housing (4) to filler
R cap housing (3) and separate housings, lift valve (12)
R from valve housing.

R 3. Install Oil Tank Check Valve

R A. Material required

| | British Spec./Ref. | American Spec./Ref. | OMat Item No. |
|---|---|---|---|
| Jointing compound | DTD900/4586 (Hylomar PL32 light) | - | 4/46 |
| Degreasing fluid | B.S.4487: (Genklene, Inhibisol) | - | 174A, 174B |

R B. Install valve

R (1) WARNING: WHEN USING DEGREASING FLUID, ENSURE ADEQUATE VENTILATION AND AVOID SKIN CONTACT AND INHALING THE VAPOUR.

Refer to fig.401, remove residual traces of jointing compound from mating surfaces of filler cap housing (3) and valve housing (4). Cold liquid degrease mating surfaces and allow to dry.

R (2) CAUTION: ENSURE JOINTING COMPOUND DOES NOT ENTER OIL PASSAGES.

Apply jointing compound to mating surfaces of valve housing (4) and filler cap housing (3), allow to dry for 10 minutes.

R (3) Insert valve (12) into valve housing (4) ensuring valve does not contact jointing compound.

R (4) Fit valve housing (4) to filler cap housing (3) and secure with bolts (11) torque tighten bolts to 55 lbf.in. (6.2 Nm).

NOTE: Prior to fitting, lubricate threads of bolts (11) with clean engine oil.

R (5) Fit and lubricate new seal ring (10) (Ref.70-02-01) to filler cap adapter (9). Ensure bolt holes are aligned and fit adapter to filler cap housing (3).

R (6) Remove temporary blank from oil tank cover aperture.

R (7) Fit new gasket (5) to oil tank cover ensuring that
R offset holes in gasket and tank cover are aligned.

R (8) On engines with S.B.72-3665, fit spacer (6) and new
R additional gasket (7) to oil tank cover ensuring that
R offset holes are aligned with cover.

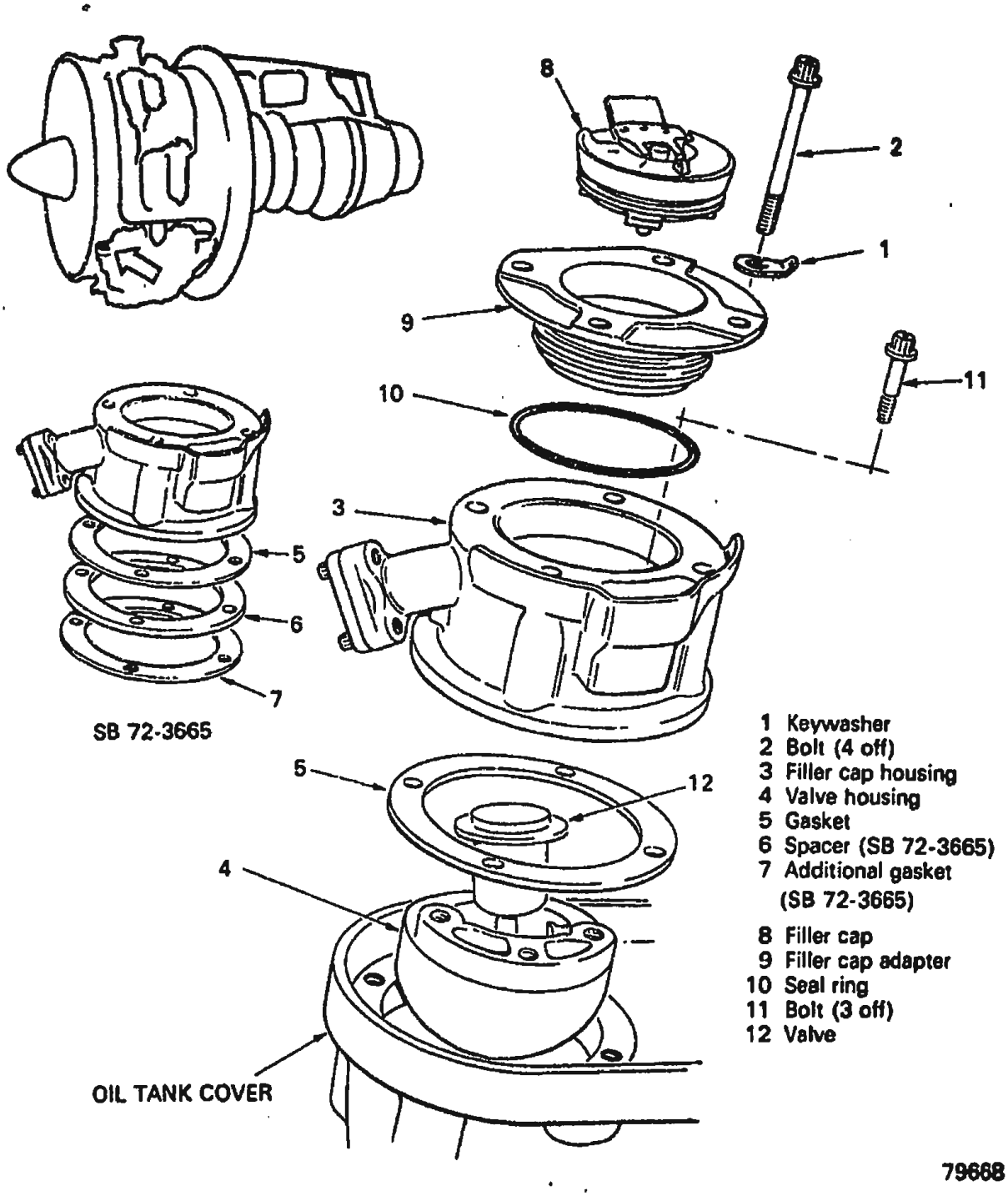
R (9) Fit filler cap housing (3), valve housing (4) and
R filler cap adapter (9) assembly to oil tank cover
R ensuring that offset holes in housing assembly and
R tank cover are aligned. Fit keywasher (1) and secure
R assembly with bolts (2). Torque tighten bolts (Ref.
R 70-51-00).

R (10) Clip filler cap retaining chain to keywasher (1).

R (11) Replenish oil tank (Ref.12-12-01).

R (12) Refit oil filler cap (8).

R (13) Close L.H. hinged cowl, 413A or 423B for engines No.1
R and No.3 (Ref.71-11-00) or 433AL for engine No.2 (Ref.
R 71-12-01).




R Oil tank check valve - Removal/Installation
R Fig.401

R EFFECTIVITY: ALL
R
050B 1A

R # OIL TANK CHECK VALVE - INSPECTION/CHECK

R 1. General

R WARNING: THE SYNTHETIC LUBRICATING OIL USED IN THIS ENGINE CAN
R CAUSE IRRITATION AFTER PROLONGED OR REPEATED SKIN
R CONTACT.

R CAUTION: CONTAMINATION BY MINUTE AMOUNTS OF CERTAIN ALKALINE
R CLEANING FLUIDS CAN CAUSE COMPLETE BREAKDOWN OF THE
R SYNTHETIC OIL. USE SCRUPULOUSLY CLEAN CONTAINERS
R AND EQUIPMENT.

R A. Service Bulletins referred to:

R 72-5682 Secondary seal float with non-stick coating

R B. Referenced Procedures:

R 72-63-10 Oil Tank Check Valve - Removal/Installation

R 2. Inspect Oil Tank Check Valve

R A. Remove oil tank check valve (Ref. 72-63-10)

R B. Refer to fig.601, inspect valve for:

R (1) Evidence of wear

R (2) Punctures in body

R (3) Dents and distortion of body or flange

R (4) Condition of non-stick coating on underside of flange
R (Engines with S.B.72-5682)

R For acceptance standards, see para.3.

R C. Inspect valve housing for:

R (1) Condition and security of rubbing strips

R (2) Seal for deterioration and flattening

R For acceptance standards, see para.3.

R D. Fit valve into valve housing, ensure valve can move freely

R For acceptance standards see para.3.

R E. Install oil tank check valve (Ref. 72-63-10)

R 3. Acceptance Standards

R A. Valve

R (1) Any evidence of wear, punctures, dents or distortion
R of body or flange. Reject valve.

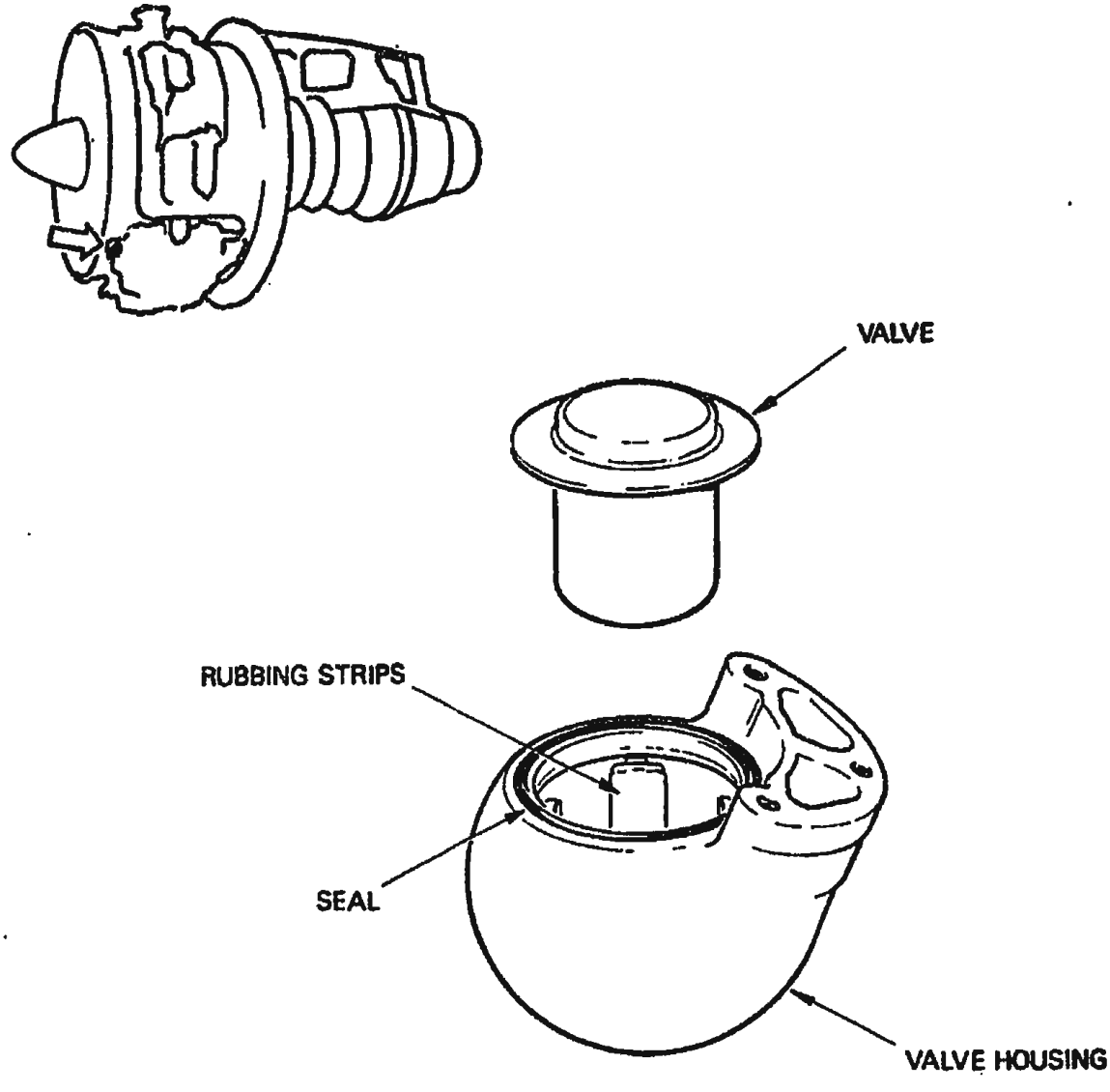
R (2) Any discontinuity of non-stick coating on underside
R of flange (S.B.72-5682). Reject valve.

R B. Valve housing

R (1) Any deterioration in condition or insecurity of
R attachment of rubbing strips. Reject housing.

R (2) Any deterioration in condition or flattening of
R housing seal. Reject housing.

R C. Any detectable tendency for valve to stick in valve housing
R during manual operation of valve. Reject valve and valve
R housing.




R Oil tank check valve inspection/check
R Fig.601

R EFFECTIVITY: ALL
R
050B 1A